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Archives OF SURGERY

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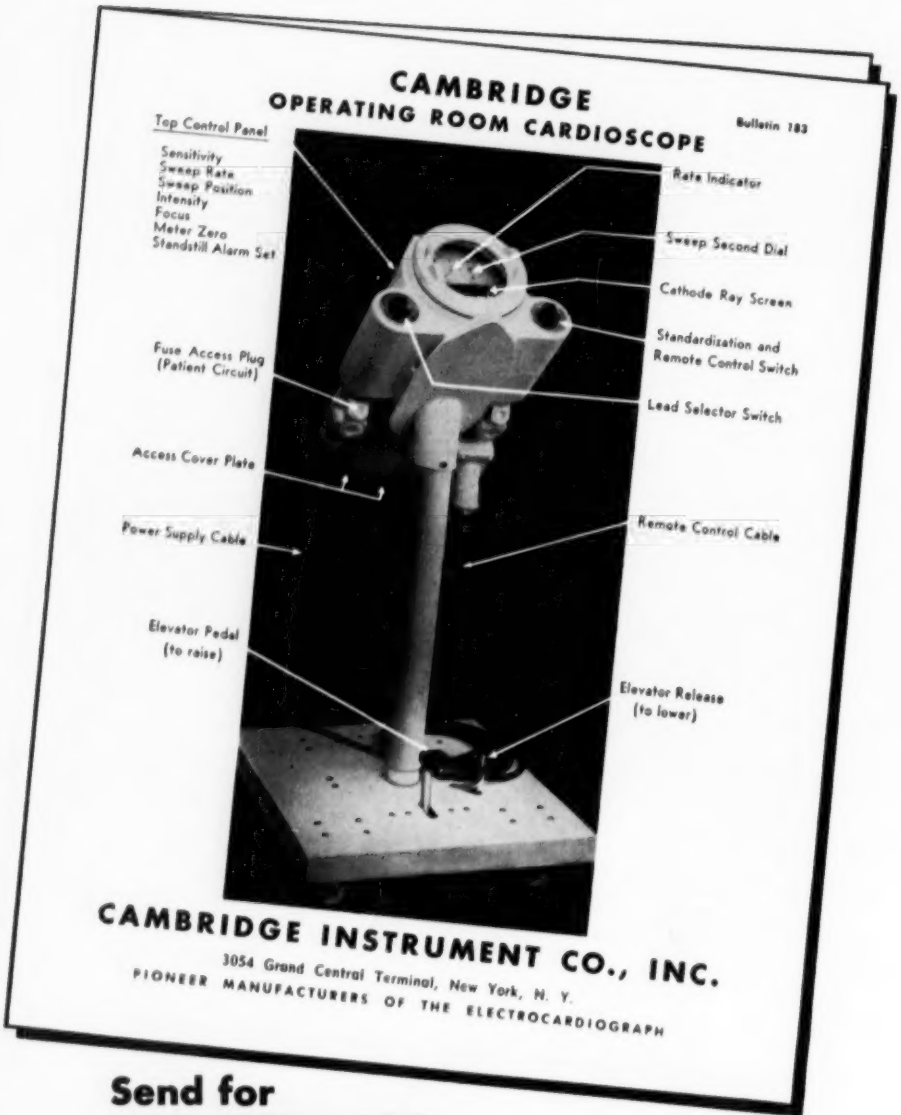
AMERICAN MEDICAL ASSOCIATION Publication



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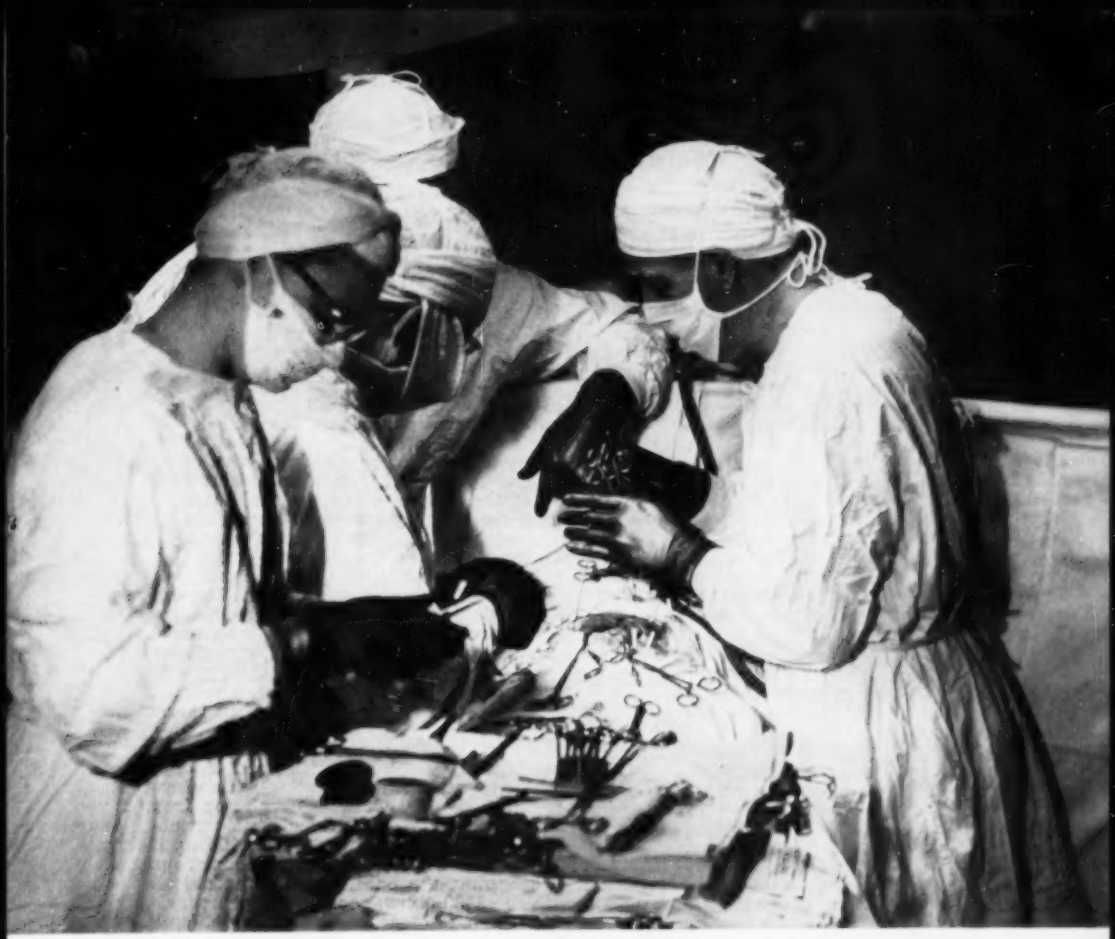

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1. Parsons, W. H., et al.: Ann. Surg. 135:791 (June) 1952. 2. Whiting, J. A., and Hotz, R.: Surg., Gynec. & Obst. 97:709 (Dec.) 1953. 3. Beling, C. A., et al.: Geriatrics 7:179 (May-June) 1952. 4. Barbour, C. M., Jr., and Tennant, R.: J. Urol. 71:497 (April) 1954.

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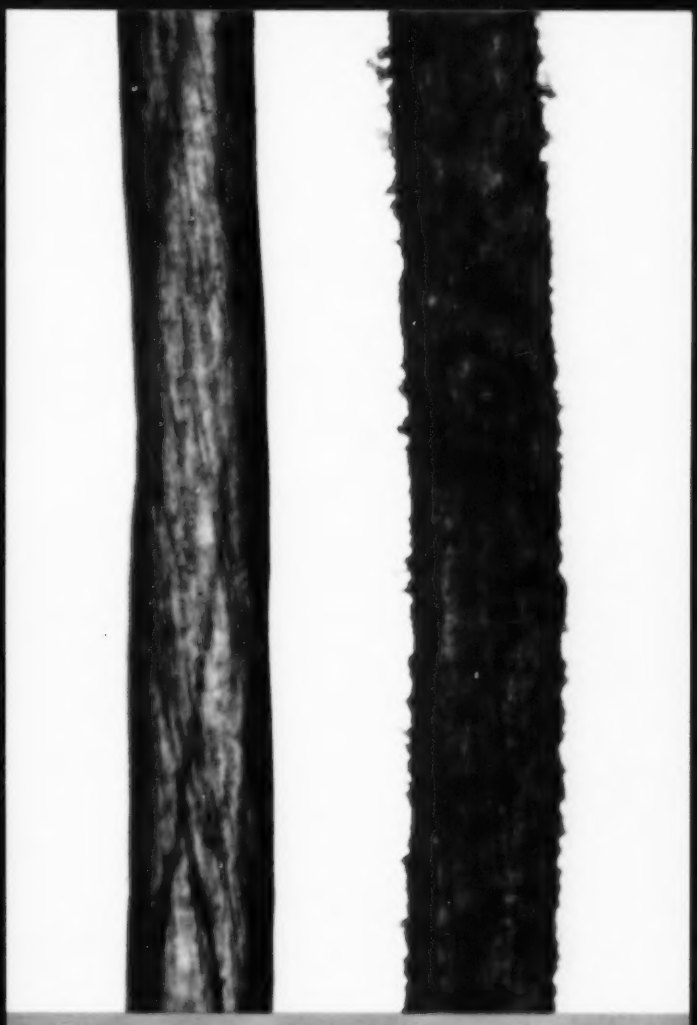
Research shows why D & G gut is stronger

PHOTOMICROGRAPHY SEES WHAT THE HAND CANNOT FEEL



Photomicrographs (unretouched) by E. J. Thomas, Stamford Laboratory of the Research Division of the American Cyanamid Company, Stamford, Conn.

Method used: dark field, transmitted bright field illumination, 120 x. Material used: medium chromic gut, size 5-0.

D & G gut

Photomicrograph shows the smooth surface of D & G SURGICAL GUT, with practically no fraying or roughness. *Reason:* Carefully controlled slitting of plies plus uniform twisting provides a smooth, well-bonded strand. No need to grind it to size. Gentle polishing gave the matte finish. *Result:* the full natural strength of each gut ribbon (ply) is preserved; the strand is not frayed by grinding.

Another leading gut

Photomicrograph reveals rough, frayed surface of another leading brand of gut. This has been ground to size. Gut processed in this way appears very uniform in diameter to the naked eye. But the photomicroscope reveals serious imperfections which may cause fraying and loss of strength when the knot is tied.

see exhibit on next page

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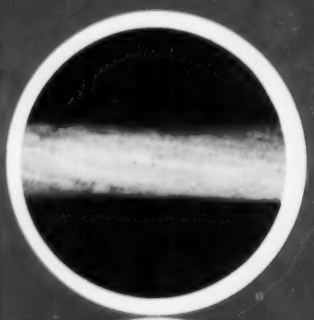

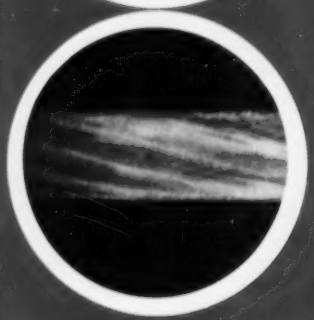

D & G GUT

Firm, even cohesion of plies is apparent in this photomicrograph of a D & G SURGICAL GUT suture. **Reason:** plies were twisted into a strand before suture was chromicized. Natural cohesive forces of moist untreated collagen firmly bond the plies together and hold the twist. **Result:** under stress, plies of the suture hold together. The D & G gut is more flexible and knot strength is greater.

ANOTHER LEADING GUT

Photomicrograph detects separate and distinct plies in a strand of another leading brand of surgical gut. Here each ply was chromicized before they were twisted into suture strands. Such "ribbon chromicizing" hardens the surface of each ply, decreasing the natural bonding action, lowering the flexibility and tensile strength of the suture.

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Method used: dark field, reflected illumination, focus on crest of surface, 32 x. Material used: medium chromic gut, size 00.

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1. Dearing, W. H., and Needham, G. M.: Proc. Staff Meet., Mayo Clin. 28:507 (Sept. 9) 1953.
2. Bargen, J. A.: Surg., Gynec. & Obst., 99:373 (Sept.) 1954.

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Editorials

OPERATIVE AND POSTOPERATIVE CHOLANGIOGRAPHY

IN THEIR excellent monograph on cholangiography, Partington and Sachs credit Saralegui with the first performance of postoperative cholangiography in 1926. In 1936, Pablo Mirizzi, Chief of the Surgical Clinic at the University of Cordoba, Argentina, first reported his studies on operative cholangiography. I had the good fortune to be asked to review his monograph on "*La cholecystectomie sans drainage.*" Half of this monograph is devoted to methods of performing cholangiography and includes good illustrations of the various types of obstructing lesions encountered. Thiessen and Walters, and many others, including Best and Hicken, and Doubilet in this country and Mallet-Guy, Bergeret, and Caroli in France, began using postoperative cholangiography. McGowan, Butsch, and Walters, and Mallet-Guy, and probably others combined studies of intraductal pressure with it.

Over the years postoperative cholangiography has established itself as a valuable procedure. In fact it has become practically a routine when T-tube drainage of the common duct has been instituted at operation. It has been helpful in demonstrating complete relief of the biliary obstruction and the continuity of flow from the bile duct into the duodenum. It also has indicated any overlooked stones in the common and hepatic ducts, unrecognized malignant lesions of the ampulla of Vater and of the pancreas, biliary stasis as a result of the squeezing of the pancreatic portion of the common bile duct by inflammatory lesions, and spasm or stenosis of the sphincter of Oddi. Since postoperative cholangiograms have been so valuable because they sometimes disclosed lesions overlooked at operation, the question naturally arose as to why operative cholangiography should not be of even greater value, for it would demonstrate these lesions at a time when they could be corrected and thus prevent a secondary operation.

In the February issue was published an interesting paper by Kantor, Evans, and Glenn on the routine use of cholangiograms at operation, both before and after choledochostomy and later during the course of the patient's convalescence. From a review of 171 operative and 234 postoperative cholangiograms, they found that of 139 patients who had choledochostomy for palpable common duct stones or "clinical question thereof," 9% retained stones after operation. It would be of interest to know the percentage of operative cholangiograms seemingly showing stones or other types of obstruction in which neither were found when the common duct was opened and explored, since unsatisfactory results were reported in "48% of the operative and 34.2% of the postoperative cholangiograms." If precholedochostomy and postcholedochostomy cholangiograms made during operations are to assume a place of importance in the exclusion of stones or other types of obstruction, the accuracy of the procedures must be greatly increased.

Recent meetings of the American College of Surgeons with the International Society of Surgery at Paris and Lyons gave opportunities to see the use at opera-

tion of fluoroscopic cholangiography, studies of intrabiliary pressure, and, in addition, the operative serial cholangiograms. Though these studies were interesting and valuable for the demonstration of some of the physiologic activities of the mechanism of the expulsion of bile from the bile ducts into the duodenum and spectacularly showed stones in the common and hepatic ducts, the stones were of sufficient size that a thorough exploration of the duct with scoops and by irrigation would have enabled their accurate removal. The practical value of fluoroscopic cholangiography and of studies of intrabiliary pressure as routine procedures at the time of operations on the biliary tract, in addition to accurate mechanical methods of exploring the common and hepatic ducts, is the debatable point, and further studies comparing the two methods are in order.

In a recent paper presented at a meeting of a Mayo Foundation group, Philip Sandblom, Professor of Surgery at the University of Lund, Sweden, gave a brief report of studies of the comparative value of (1) palpation of the common duct, (2) palpation of the common duct over a probe passed through the cystic duct and lower part of the common duct into the duodenum, and (3) operative cholangiography in the same cases. Since this work is to be reported in detail later by the investigators, Stig Borgstrom and Olof Norman, only a brief mention will be made of their studies. A series of 2,048 operative cholangiograms were made at the University Hospital in Lund between the years 1947 and 1953. They were made as a routine measure in all cases in which operations were performed for lesions of the biliary tract. Studies covered several phases of extrahepatic biliary calculi. Among these studies was the comparative one in which the three procedures just described were used to determine the presence of common duct stones in 47 cases in which removal of common and hepatic duct stones was effected. When the duct was palpated after kocherization of the duodenum, stones were missed in 18 cases. In five cases, these stones were 5 mm. or more in diameter. In 12 cases, it was thought that stones were palpated, but none were found at choledochostomy or on cholangiography. When a probe was passed through the cystic duct and the lower part of the common duct into the duodenum and the common duct was palpated over the probe, stones were not palpated in 12 cases. However, these stones were all less than 5 mm. in diameter. In four cases, stones were believed to be present, but none were demonstrated by cholangiography. When cholangiograms were done in these cases (and this is one of the most important points of their study), two stones were missed, both of which were 5 mm. in diameter; in 3 cases stones were thought present but were not found at operation; in 13 cases, the cholangiograms were indeterminate, and in 1 of these cases a stone was found. In 8 cases, the common duct stone was so large that a cholangiogram was not thought necessary. In other words cholangiograms were done in 39 of the 47 cases. When a comparison is made of the results by palpating the common duct with a probe passed through the cystic duct into the duodenum and by the use of the cholangiogram, it will be noted that the difference in the total number of errors is not great. Moreover, of the 12 stones that were missed by palpation over the inserted probes all were less than 5 mm. in diameter. The question follows as to whether these small stones might not have been washed out if the ducts had been flushed with water or would not have passed through the duct if the sphincter had been dilated to a diameter of 8 mm., which should be a customary part of exploration of the common and hepatic ducts with scoops of varying size.

Because of the frequent entrance of the cystic duct into the common duct at an acute angle, it is usually impossible to explore the intrahepatic ducts accurately

through the cystic duct. Hence exploration should include incision in the common duct at a point which permits thorough exploration of the interior of the right and left hepatic ducts as well as the lower end of the common duct since in some cases stones are found within the hepatic ducts. In addition, flushing the ducts with water in these cases should be routine, as stones which the scoops have passed by will be washed up or down and out of the incision in the common duct. It is obligatory too that a 4 mm.-scoop and then an 8 mm.-scoop be passed through the lower end of the duct into the duodenum and that the duct be carefully palpated with such scoops in such position. Sometimes scoops will pass by small stones in the ampulla. Most of the time stones in the ampulla will prevent passage of a scoop, and in these cases, if necessary, the duodenum must be opened to exclude the possibility of an impacted ampullary stone or a small malignant lesion at the lower end of the common duct. After the ducts have been repeatedly searched with scoops and the scoops passed into the duodenum, the ducts should be flushed out again and the ducts again searched with scoops for stones. If these procedures are accurately done, few stones would be overlooked in the common or hepatic ducts, and it is reasonable to assume that small ones (less than 5 mm. in diameter) that might not have been removed will pass through the duct and the dilated sphincter of Oddi into the duodenum during the early postoperative period.

The accuracy of the method of exploring the common and hepatic duct employed by me has been substantiated by routine postoperative cholangiograms in all of my cases of this type since 1936. No record was kept of the percentage of overlooked stones for about 10 years, although they were few in number. Since 1946, only four cases are recalled in which a common or hepatic duct stone was overlooked at exploratory choledochostomy. However, the exploration of the common and hepatic ducts was much more thorough than passage of a probe through the cystic and lower end of the common duct into the duodenum.

WALTMAN WALTERS, M.D.

SITES OF PEPTIC ULCERATION

THE STEADILY increasing laboratory and clinical evidence that ulceration in the upper gastrointestinal tract is due to the corrosive effect of the gastric content is now so complete that it is no longer permissible to state that the cause of duodenal and gastric ulcers is unknown. Many problems, however, remain, and one of these has to do with the sites of predilection for these lesions. Ulcers near the stoma of a gastrojejunostomy or gastroduodenostomy may be accounted for since there is now proof that the normal duodenal and jejunal mucosa has less resistance to the digestive action of pure gastric juice than is the case with the gastric mucosa. Ulceration in the lower end of the esophagus and in the ileum opposite the entrance of Meckel's diverticulum containing heterotopic gastric mucosa is probably due to similar reasons. Why, however, do the large majority of ulcers occur along the lesser curvature of the middle portion of the stomach and in the first 2 or 3 cm. of the duodenum? At first glance, all parts of the stomach would appear to be equally exposed to the digestive action of the gastric content and, accordingly, ulcers should occur in all parts of the stomach with equal frequency. Benign ulcers on the greater curvature are, however, so rare that such a lesion in this region is a curiosity and must be scrutinized carefully because of the probability that it is a carcinoma.

The view that gastric and duodenal ulcers are different diseases is not a new one, although both are due to the digestive action of the gastric content and are appropriately called peptic ulcers. In a recent paper,[1] I have summarized the evidence supporting the view that duodenal ulcers are due to a hypersecretion of gastric juice of nervous origin, whereas gastric ulcers are due to hypersecretion of gastric juice of humoral origin. In both cases the gastric juice, which is the principal corrosive component of the gastric content, comes from the glands in the body and fundus of the stomach, and the question arises why in the one case it produces a lesion in the duodenum and in the other a lesion in the stomach. The hypersecretion of gastric juice in duodenal ulcer patients is usually accompanied by hypermotility, both due to a hypertonus of the vagus nerves. This hypersecretion and hypermotility occur in the empty stomach as well as during periods of digestion. In both cases the hyperacid gastric contents are hurried on into the duodenum. The duodenal mucosa is less resistant to the digestive action of gastric juice than is the gastric mucosa, and so it is not surprising that the first portion of the duodenum which comes in contact with the acid gastric content succumbs to its corrosive action.

Hypomotility of the stomach with prolonged stasis of food is frequently found in gastric ulcer patients, and it is likely that this prolonged contact of food with the antrum mucosa is in part responsible for the hypersecretion of gastric juice of humoral origin in these patients. The prolonged presence of a corroding gastric content in the stomach in the presence of hypomotility or of pyloric stenosis seems sufficient to account for the location of gastric ulcers. Why, however, do they occur chiefly on the lesser curvature and not on other areas in the gastric wall?

From the Department of Surgery, The University of Chicago.

Inspection of the empty, the partially filled, and the distended stomach demonstrates that the stomach does not enlarge equally in all directions to accommodate a meal. The lesser curvature is relatively fixed, and the mucous membrane in this area is smooth. Along the greater curvature, however, the mucous membrane is heaped in folds which straighten out when the greater curvature descends as the stomach is filled with food. It is thus evident that the mucous membrane along the lesser curvature of the stomach is at all times exposed to the gastric content, whereas the mucosa in other parts of the stomach in the relaxed or semirelaxed state may be protected from the gastric content by folding. It seems likely that it is this exposure to the gastric content rather than a local decrease in resistance that accounts for the site of the lesion. Attempts to demonstrate a local decrease in the resistance of the gastric mucosa on the basis of vascular impairment, as called for in the theory of Virchow and Hauser, in the neighborhood of gastric ulcers have usually failed. Furthermore, it has been the experience of surgeons that local resection of ulcers is frequently followed by recurrence in some neighboring area, indicating that the factors producing the lesion are still operative in the stomach and that the fault does not lie in some local defect in the gastric wall.

LESTER R. DRAGSTEDT, M.D.

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Boari Operation in Case of Solitary Kidney

Treatment of Obstruction of Solitary Ureter Following Hysterectomy

V. M. DUNFIELD, M.D., South Dayton, N. Y.

In 1896, Boari * reported an operation on a dog in which he utilized a flap of bladder wall reflected from the base upward and fashioned into a tube to replace the lower end of the ureter. The dog lived four years in apparent good health. However, no autopsy findings are recorded. In 1924, Demel † reported a series of operations on dogs in which he bisected the bladder and used the upper half to replace the lower ureter. Baidin,[5] in 1930, described the use of the Demel procedure on the first human in the medical literature. His case was that of a ureterouterine fistula. The result was good, and he reported that four years postoperatively urine was spouting from the high orifice. This writer claimed that two-thirds of the ureter could be thus replaced. In this country, Spies, Johnson, and Wilson,[6] in 1933, published two papers describing the use of the Boari flap method in experimental animals. The first paper reported that a stricture invariably followed the operation, but in the second publication it was stated that a more successful technique had been achieved by the implantation of the renal end of the ureter into the side of the bladder tube. In 1937, Rohde [7] reported a case of ureteral fistula which was successfully treated by the method of Demel. His follow-up covered a four-month period only, possibly because of the fact that his case was one of carcinoma of the uterine cervix in an advanced stage.

In 1939, Ockerblad and Carlson [8] and, in 1947, Ockerblad [9] reported the first case in a human in which the Boari method was utilized. This patient showed no stricture at the end of 10 years. Flocks,[10] in 1946, and Henderson,[12] in 1951, each reported a single case in which operation was performed, with good results. Barnes and Farley [11] described a series of calves subjected to this procedure and presented an excellent history of the operation. In all, three cases of the repair of lower ureteral defect in which the Boari operation was used in humans are reported in the literature.

This report concerns a case of total anuria due to obstruction of a solitary ureter restored to normal bladder function by means of the Boari procedure.

REPORT OF A CASE

F. M., a 49-year-old woman, was admitted to the Tri-County Memorial Hospital on Feb. 1, 1953, with a diagnosis of uterine fibromyomata. She gave a history of having had a left nephrectomy in 1943 for nephrolithiasis. In 1952 she had generalized peritonitis due to a ruptured appendix.

Hysterectomy was done on Feb. 6, 1953, when an 8 by 9 by 7 cm. uterus with a 5 by 7 by 5 cm. mass on its right side was found adherent to the right pelvic wall. This mass was said to have been removed with great difficulty, owing to adhesions to the pelvic wall. On February 10, the patient was seen on the urologic service because of complete suppression of urine after surgery. She was critically ill and nearing coma. The N.P.N. was 75 mg. per 100 ml.; the serum protein, 5.5 gm., and the serum chloride as sodium chloride was 640 mg. per 100 ml. of serum. At cystoscopy the bladder contained 10 ml. of turbid fluid; the ureteral orifices could not be visualized because of a thick, fibrinous, hemorrhagic, plastic exudate covering the region of the bladder neck and trigone. In addition, the bladder floor was markedly elevated and distorted, presumably by edema of the operative area.

From the Urological Service, Tri-County Memorial Hospital.

* References 1 and 2.

† References 3 and 4.

Figure 1.

Since catheterization of the right ureter was impossible, nephrostomy and decapsulation was elected as a life-saving procedure and was performed the same day. Immediately upon the patient's return from surgery the nephrostomy began to function, and the first 24 hours the output was 2950 ml. of urine. On the second day the N.P.N. had returned to 38 mg. per 100 ml. Cystoscopy, on Feb. 20, showed almost complete disappearance of the hemorrhagic exudate in the bladder and relatively normal configuration of the trigone. A No. 5 F. catheter was arrested at 5 cm.; opaque medium injected into this catheter was seen to extend beyond its tip to the level of the inferior border of the right sacroiliac joint and, when injected simultaneously through the nephrostomy catheter, to extend down the ureter to within 1 cm. of the lower column, indicating a stricture approximately 1 cm. in length (Fig. 1). Across this stricture a very faint trickle of dye could be seen. On Feb. 22 the patient developed a mild pleural effusion in the left thoracic cavity; she responded well to treatment, and on March 3 she was returned to surgery. The suprapubic incision was reopened, and the ureter was approached transperitoneally; this approach was selected because dense adherence of the pelvic peritoneum to the pelvic wall was feared in view of the previous extensive pelvic manipulation. The posterior parietal peritoneum was incised lateral to

Figure 2.

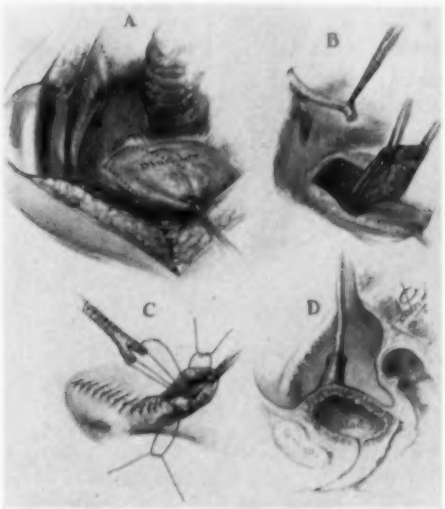

Figure 3.

Figure 4.

the ureter below the pelvic brim. The ureter was exposed and followed downward to a dense annular stricture at the level of the lower border of the ilium. The distal ureter was extremely tortuous and densely adherent, and so an end-to-end anastomosis was considered not to be feasible because of anticipated difficulty in performing future ureteral dilatations. Because of the high level of the stricture, it was seen that the ureter could not be approximated to the bladder for a direct implantation without tension. The ureter was therefore transected 0.5 cm. above the stricture, and the distal end was ligated and dropped back. An incision was made in the posterolateral bladder wall in the shape of a truncated cone with the base upward, measuring 6 cm. at the base, 6 cm. at each side, and 4 cm. at the apex (Fig. 2*A*). This was reflected cephalad (Fig. 2*B*), and the defect in the bladder wall was closed to within 1.5 cm. of the apex of the flap with one layer of interrupted sutures. The distal end of the ureter was then split for a distance of 1 cm., and each flap so constituted was sutured through and through to the apex of the bladder flap (Fig. 2*C*), each diagonally across from the other, the knot being tied on the peritoneal surface of the bladder 1 cm. from the apex. A No. 6 catheter was then passed to the kidney pelvis, and the distal end was left coiled up in the bladder (Fig. 3). The sides of the bladder flap were then closed with interrupted sutures, thus completing a tube, to the inner surface of which the ureter was anastomosed (Fig. 2*D*). Two supporting sutures were then placed between the bladder tube and the ureter, with care not to penetrate too deeply into the ureteral wall. At this stage the ureter was seen to traverse the lesser pelvis approximately 3 cm. out from the pelvic wall with very little tension. No attempt was made to peritonealize the ureter. The cecum was approximated to the pelvic wall in an effort to close a possible site for strangulation of the bowel. The wound was closed without drainage; a No. 26 Foley catheter was placed in the bladder, and the nephrostomy drain was preserved.

Clinical Course.—On the first postoperative day the output per urethra was 110 ml., and by the end of the first week it had dropped to 15 ml. in 24 hours. On the eighth day cystoscopy was done and the ureteral catheter was removed. The bladder incision was well healed, and, by following the scar upward, the artificial diverticulum was located high in the fundus. It appeared as a deep fold in the bladder wall. The Foley catheter was not replaced, and in the next 24 hours the voided output was 305 ml. and the nephrostomy output 460 ml.

Figure 5.

On the 10th day the nephrostomy tube was clamped off one hour out of every three. On the 11th day a cystogram was made (Fig. 4), which demonstrates the appearance of the bladder appendage. On the 13th day there was a sharp rise in temperature and cessation of nephrostomy drainage. After insertion of a new nephrostomy tube, drainage resumed, and in 12 hours 650 ml. was excreted by that route, after the administration of intravenous fluids, and the temperature rapidly dropped to normal. On the 14th day the output was 950 ml. by nephrostomy and 275 ml. by urethra. On the 18th

Figure 6.

day cystoscopy was repeated. The bladder scar was again used to locate the diverticulum, at the apex of which the ureteral orifice was easily entered with a No. 5 catheter, followed by a No. 6, both of which passed without difficulty to the kidney pelvis (Fig. 5). (Note the reappearance of the pelvic curve as compared with that in Figure 3.) The No. 6 catheter was left in situ, and the nephrostomy tube was withdrawn. On the 20th postoperative day the nephrostomy wound was dry and remained so. On the 22nd day the ureteral catheter became occluded, and the patient was voiding urine which was being passed around the catheter. The catheter was thereupon removed, and the voided 24-hour output was 855 ml. The patient was discharged on the 25th postoperative day in good condition, with an average daily output of 870 ml.

The patient was readmitted Aug. 19, 1953, at which time the bladder mucosa was normal in appearance. A No. 6 olive-tip catheter was again easily inserted. Phenolsulfonphthalein returned in good concentration in three and one-half minutes; there was no evidence of pelvic retention, the flow being rapid but intermittent. The right kidney was well visualized and showed evidence of reversal of the former hydronephrotic process in comparison with previous films. Urine from the right ureter showed 10 white blood cells per high-power field in the centrifuged specimen, and an organism of the Proteus group was isolated. In spite of this, the patient was asymptomatic and was carrying on her household work unassisted. She was readmitted Dec. 7, 1953, at which time the bladder was again normal in appearance; phenolsulfonphthalein was 24% excreted in the first 20 minutes; there were 15 white blood cells per high-power field in the centrifuged specimen, and culture revealed a growth of Pseudomonas pyocyaneus. In the pyelogram made at this time and shown in Figure 6 there was continued improvement in the configuration of the collecting system, and good ureteral peristalsis was well demonstrated. The patient continued to be asymptomatic.

COMMENT

Spies and co-workers discussed the desirability of reflecting the bladder flap downward in order to preserve a better blood supply for the flap. This would appear unwarranted, since sufficient length to bridge a marked ureteral defect could not thus be easily attained. When the abundant blood supply of the bladder wall and its remarkable healing power in the presence of severe trauma are considered, the location of the base of the flap would appear to be secondary to the need for bridging the gap with the minimum amount of tension on the anastomotic site. The amount of retraction and shrinkage of the flap after it was freed occasioned no little chagrin, and in the future the estimated length will be doubled whenever possible. The flap, however, possesses considerable elasticity, which appears to act as a cushion against tension on the ureter. Great care was taken to place all sutures submucosally. No attempt was made to secure a watertight suture line between the bladder and the peritoneal cavity, by placing

a second line of sutures. Complete reliance was placed on the Foley catheter to prevent extravasation of urine into the peritoneal cavity, and this confidence appears to have been well founded. The technique of injecting a ureter from each end simultaneously by means of both a nephrostomy and a ureteral catheter, in order to demonstrate a stricture, is believed to be unique. While it will not be widely applicable, it was very helpful in quickly locating the strictured area at the operating table. The fact that this case was brought to a successful conclusion in the presence of a solitary kidney, which multiplied the difficulty enormously, would indicate that the procedure is practical and, in most instances, preferable to an end-to-end anastomosis.

SUMMARY

For the first time in the literature the use of the Boari operation in a case of solitary kidney is described. The indication for the operation was a dense annular stricture of the lower third of the ureter, which had produced four days of anuria after hysterectomy. This anuria had been treated by nephrostomy. The method of diagnostic study and the restoration of normal micturition by means of an anastomosis of the shortened ureter to an upward-reflected flap of bladder are described.

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Relation of Gallstone Disease to Angina Pectoris

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Forty-five years have gone by since Robert Babcock,[1] of Chicago, in a paper published in *The Journal of the American Medical Association*, called attention to the frequent association of gallstone disease and cardiac disease. He stated, in part, that

> There is, however, another point of interest in the matter of the symptomatology of gallbladder disease, namely, the occurrence of disorders in the action of the heart, from arrhythmia and precordial oppression, without dyspnea, to demonstrable dilatation and incompetence, dating usually from some attack of biliary colic or acute cholecystitis, and thenceforth maintained by recurrences of the acute disturbance.

He reported 13 patients having this syndrome and concluded

> Experience has convinced me that the opening and draining of the gallbladder are attended with less danger when properly performed, even though myocardial incompetence be present, than is the doctrine of non-interference.

David Riesman,[2] of Philadelphia, had two years previously reported two patients observed by him who developed a systolic murmur at the apex and increased cardiac dullness during, or directly after, an attack of gallstone colic, and two years after the publication of Babcock's paper he again called attention to this relationship.

Tennant and Zimmerman[3] and others* have called attention to the fact that gall bladder disease, especially gallstone disease, and cardiac disease are jointly present in many patients.

Until 1935, when Fitz-Hugh and Wolferth[6] published their paper, "Cardiac Improvement Following Gallbladder Surgery," no fundamental data were published on this subject. These authors stated that

> The difficulties of differential diagnosis between certain forms of heart disease attended by pain and certain types of gallbladder disease have long been emphasized. An attack of angina pectoris or acute coronary occlusion may so closely mimic acute calculous obstruction of the biliary tract, or some other more surgically imperative catastrophe in this region that the surgeon may be disastrously tricked into operating. Conversely a patient with gallstone disease may present such a convincing array of cardiac symptoms that the internist may wrongly condemn the sufferer to a "life sentence of cardiac servitude."

For the first time, these authors presented electrocardiographic data taken before and after operation on a group of patients all of whom exhibited cardiac symptoms. The patients in the main had anginoid symptoms, but for the most part these symptoms were not associated with effort, "and all were found to have abnormal electrocardiographic tracings; chiefly flat or inverted T waves in the first two leads." They observed the return to normal in the electrocardiogram in certain of their patients after operation and stated that "the majority of patients with coronary and myocardial types of heart disease, or with symptoms and electrocardio-

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Read before the Section on Surgery, General and Abdominal, at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 24, 1954.

* References 4 and 5.

graphic findings suggestive of these disorders, who have associated gallstones, are usually greatly benefited by skillful and judicious gall-bladder surgery."

Their statement that the electrocardiographic changes were frequently reversible was rapidly confirmed by Weiss and Hamilton,[7] who further pointed out that the rapidity with which the return to normal took place suggested strongly "a toxic cardiac myopathy induced by the presence of a diseased gallbladder."

Gilbert[8] and his associates[9] have published data which suggest a decrease in coronary blood flow upon distention of the gall bladder and distention or irritation of the bile ducts. Bellet and Meade† and, more recently, Wechsler, Kaplan, Bellet, and Nemir[11] have attempted to produce significant changes in the electrocardiogram of the dog by distention of the gall bladder or common duct. Neither of these authors obtained changes in the electrocardiogram unless prior to distention of the extrahepatic biliary system some abnormality of the coronary blood flow had been induced.

In 1942, Ravdin, Royster, and Sanders[12] reported evidence in man that distention of the common duct produced the symptoms of angina pectoris and that when the distention was relieved, the symptoms disappeared. These authors reached the conclusion that

> Reflexes arising in the extrahepatic bile passages may at times bring about a restriction in coronary blood flow which produces the symptoms of angina pectoris. When the extrinsic factors giving rise to these reflexes are removed, the anginal symptoms disappear. Similarly such reflexes may further decrease the coronary blood flow brought about by intrinsic changes in the coronary vessels. While adequate surgery does not completely relieve the patient of his cardiac symptoms, some measure of relief is nearly invariably obtained.

It remained for Cullen and Reese,[13] using radioactive Na^{24}, to demonstrate beyond question that "Rapid distention of the common bile duct with the vagus nerves intact lowers myocardial blood flow" and that "When both vagi are cut in the neck, common bile duct distention does not alter myocardial blood flow." The Table is a reproduction of one of their tables illustrating this effect.

*Myocardial Circulation, Blood Pressure, and Pulse Before and After Common Duct Distention**

Dog No.	Myocardial Circulation		Blood Pressure		Pulse	
	Before	After	Before	After	Before	After
1	1.051	0.910	136	96	150	142
2	0.393	0.321	...	...	...	...
3	0.745	0.733	108	104	108	90
4	0.314	0.302	126	106	148	136
5	0.403	0.425	96	120	144	225
6	0.652	0.441	124	98	220	196
7	0.553	0.264	114	92	164	148
8	0.870	0.660	90	50	210	190
9	0.900	0.735	84	72	128	128
10	0.309	0.091	...	...	...	...
Av	0.618	0.488	109	92	159	157

* Modified from Table by M. L. Cullen and H. L. Reese, *Journal of Applied Physiology* 5: 281, 1952.

We wish to present case histories representing various aspects of this complex problem, with the hope that others will realize that each patient deserves careful study and evaluation by internist and surgeon before final opinions are made.

REPORT OF CASES

Anginal Type.—Mr. D. H. was admitted to the Hospital of the University of Pennsylvania, March 5, 1950, on the service of Dr. T. Fitz-Hugh Jr. A 76-year-old former senator from an eastern state, he had suffered attacks of RUQ pain, belching, and fatty food intolerance for many years. A cholecystogram in 1945 revealed a nonfunctioning gallbladder containing calculi.

† Bellet, S., and Meade, R. H.: Unpublished data, cited by Bockus.[10]

Associated with the gastrointestinal symptoms was a substernal pain which did not radiate. An ECG taken at another hospital after such an attack three months prior to admission showed evidence of myocardial ischemia, and a diagnosis of coronary artery sclerosis was made by a cardiologist in another city. The patient was advised to give up golf and to restrict his activities in the practice of law.

Examination at this admission showed a blood pressure of 146/74, temperature of 99 F, and pulse rate of 72. There was a soft apical systolic murmur.

ECG after admission showed changes compatible with left ventricular abnormality or digitalis effect.

It seemed that the diseased gall bladder might well be aggravating existing coronary disease. It was agreed that the present asymptomatic interval would be an advantageous time for operation.

On March 13, 1950, with the patient under general anesthesia, cholecystectomy was performed. The gall bladder was chronically diseased and contained six calculi. The common duct was of normal size and was not explored.

Convalescence from this procedure was uncomplicated, and the patient was discharged on the 12th postoperative day.

It is now more than four years since he left the hospital. He has had no further symptoms referable to the biliary tract nor further attacks of substernal pain such as those he suffered prior to operation. Digitalis was discontinued before discharge from the hospital, and an ECG three weeks later was perfectly normal and has remained normal. The patient resumed his participation in golf and in his active law practice. Although he is now more than 80 years of age he has no anginal symptoms, even with effort, and he enjoyed a period of hunting last fall, without symptoms. Figure 1 is a comparison of the preoperative and postoperative electrocardiograms in this case.

Anginal Type.—Dr. H. R., a 75-year-old surgeon, was admitted to the service of Dr. I. S. Ravdin on Jan. 28, 1947. For about four months prior to admission he had had attacks of epigastric pain with an associated marked substernal element. In addition, a diagnosis of coronary occlusion had been made 10 years previously, and the patient had given up the practice of surgery because of this. The present attack began about 10 days prior to admission and was the most severe he had had.

Examination revealed the presence of extrasystoles and a very tender mass in the RUQ of the abdomen.

White blood cell count was 6600, and urinalysis was essentially negative.

It was believed that the patient probably had empyema of the gall bladder. Dr. T. Fitz-Hugh Jr.,

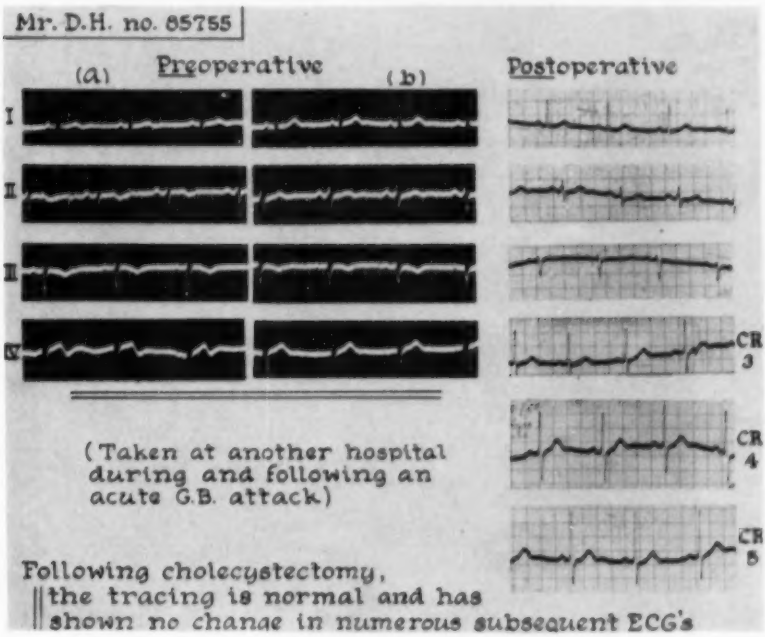

Figure 1.

who was asked to see him, felt that he could probably withstand cholecystostomy. No evidence of acute cardiac infarction was found.

Accordingly, on the day of admission he underwent operation under local anesthesia. An empyema of the gall bladder containing about 100 cc. of purulent brown fluid was found. Cholecystostomy was performed.

The postoperative course was entirely smooth. The postoperative cholangiogram indicated some blockage of the cystic duct, probably due to a calculus. The patient was discharged on March 1, 1947, to return at a later date for more thorough exploration of the biliary tract.

On May 7, 1947, with the patient under general anesthesia, cholecystectomy and choledochostomy were performed. A stone was found in the cystic duct and another was found in the common duct.

The postoperative course was uneventful; the cholangiogram on the seventh postoperative day showed a patent common duct. The T-tube was removed.

Since operation, seven years ago, the patient has been symptom-free, without recurrence of substernal pain. He has no effort syndrome.

Reflex Arrhythmia.—Mr. A. H. was admitted to the service of Dr. I. S. Ravdin on Jan. 4, 1946. This 64-year-old man was in relatively good health

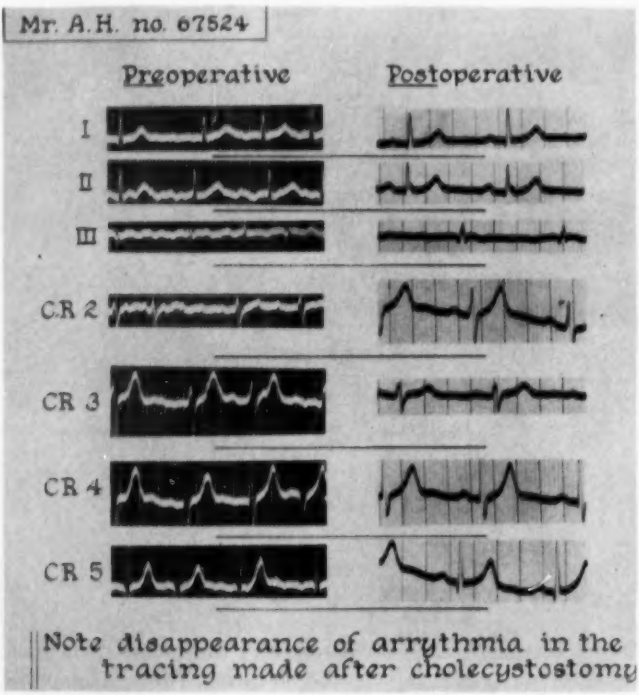

Figure 2.

He was readmitted on May 4, 1947, for cholecystectomy and common duct exploration. In the interval since discharge mucoid material continued to drain from the gall bladder, but the patient had been symptom-free, except for a few occasions when the mucus discharge would temporarily stop. At these times, he had epigastric and substernal attacks of pain similar to those suffered before operation. There had never been jaundice, but some of his stools were light colored.

Examination on this occasion showed normal sinus rhythm and a fistula at the outer end of a right subcostal incision.

until two days before admission, when he noted the onset of vague, poorly localized pain in the right side of the abdomen, bloating, and nausea, but no vomiting. Just prior to this attack there had been a sharp precordial pain which was of short duration and did not radiate. On systemic review, it was noted that he had suffered from shortness of breath on exertion for about eight years.

Examination revealed a temperature of 98.8 F and a pulse rate from 96 to 104, totally irregular. The blood pressure was 180/120. The abdomen was protuberant and somewhat guarded but not defi-

nitely tender. There were signs of congestive heart failure.

The patient was seen in consultation by Dr. J. Säyen, of the Cardiology Section, who confirmed the impression that he had auricular fibrillation, and this was checked by an ECG, which demonstrated the arrhythmia. At Dr. Säyen's suggestion he was rapidly digitalized, and it was agreed to observe him until definition of his abdominal problem became more clear cut.

During the ensuing 48 hours, his temperature continued to increase, and it was possible to feel a mass in the right side of his abdomen.

Therefore, an exploratory operation was immediately performed. A large distended gall bladder that was partly gangrenous and contained several hundred stones was found; cholecystectomy was performed.

Aside from one brief bout of auricular fibrillation on the first postoperative day, normal sinus rhythm was observed during the remaining hospital stay. Digitalis was stopped on the fourth postoperative day. ECG (Fig. 2) obtained after return of normal rhythm showed only an increased PR interval and was otherwise normal. The patient was discharged on the 12th postoperative day.

During the eight years since discharge he has had no further cardiac or digestive symptoms and is at present enjoying an active life.

Gallstone Disease and Probable Heart Disease.—Mrs. R. G. was admitted to the service of Dr. I. S. Ravdin on March 9, 1942. She was 55 years old and had an 18-month history of attacks of crampy right upper quadrant pain which did not radiate. These were always postprandial or nocturnal, accompanied by flatulence and a feeling of "oppression" in her chest.

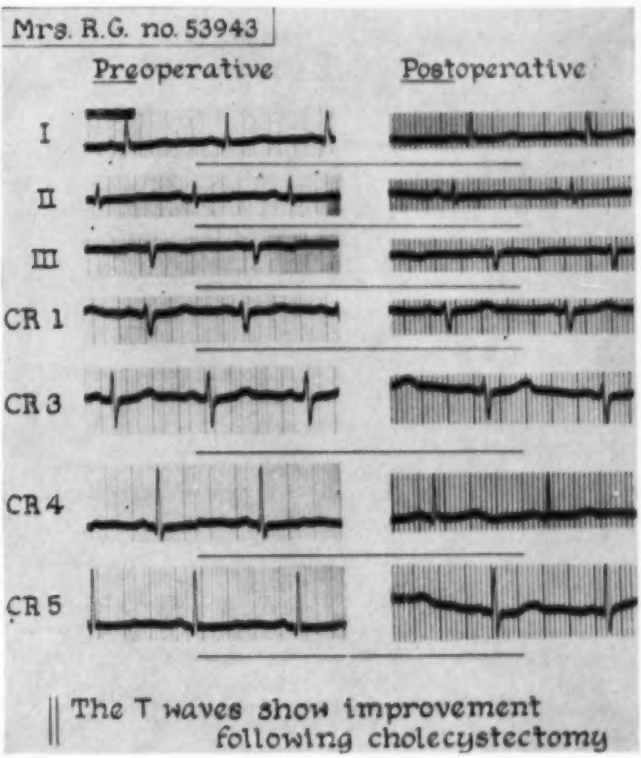

Figure 3.

She had one questionable bout of jaundice one week prior to admission but no acholic stools. The gastrointestinal clinic of this hospital had been following her and referred her for cholecystectomy because the attacks were becoming more frequent and severe. A cholecystogram ordered by the clinic showed an abnormally functioning gall bladder in which no stones could be visualized.

Study at another hospital during acute exacerbation of gall bladder symptoms revealed ECG evidence of "myocardial disease with beginning intra-

ventricular block, a finding which sometimes occurs associated with gallstone disease (QRS complex widened, S-T segments depressed in Lead 1, T waves inverted in Leads 2 and 3)."

Examination was essentially negative except for accentuation of the aortic second sound.

Routine laboratory studies were within normal limits. The Van den Bergh test was 0.7 mg., indirect. ECG showed T waves low in Leads 1, CR 1, and CR 3, diphasic in Leads 2, CR 4, and CR 5, and left axis deviation. The tracing suggested left ventricular hypertrophy. These electrocardiograms are shown in Figure 3.

On March 11, the patient was operated upon under spinal anesthesia, and a chronically diseased, shrunken gall bladder was found which contained 10 small stones. The common duct was normal.

The postoperative course was uncomplicated, and an ECG on the 14th postoperative day showed no change from the previous tracing.

After discharge from the hospital the patient was still troubled by occasional attacks of epigastric pain. She was seen by Dr. C. C. Wolferth seven months after operation, and he found no evidence of cardiac disease. An ECG showed marked improvement in the T waves in both limb and chest leads.

Gallstone Disease and Coronary Infarction.—S. B., a 53-year-old man from a midwestern city, was admitted to the service of Dr. I. S. Ravdin on Feb. 7, 1954, with a two-year history of attacks suggestive of biliary tract disease with substernal reference. Cholecystogram in May, 1953, showed a functioning gall bladder containing three large calculi. The history revealed information that, in addition to digestive symptoms, he had had a very severe attack of chest pain radiating down both arms, coupled with sweating on Jan. 3, 1954. This had disappeared by the next morning. An ECG done on Jan. 4, 1954, showed positive RS-T segment displacement in Lead 2. No diagnosis of coronary infarction was made, and he continued his regular life.

The ECG was repeated shortly after admission and indicated that he had a major posterolateral infarction. It was the opinion of Dr. C. C. Wolferth that this lesion probably had occurred with the attack of chest pain on January 3 and was now in a healing stage. It was agreed that, since the gall bladder situation was not acute, three months should be allowed to elapse before proceeding with cholecystectomy.

The patient was readmitted on May 4, 1954, having had several biliary attacks in the interim but no further attacks of chest pain. The symptoms consisted of RUQ pain and gaseous distention, usually coming on at night, most commonly after ingestion of fatty or greasy foods. He was asymptomatic at the time of admission.

Examination was essentially negative except for the presence of right rectus and right inguinal herniorrhaphy scars.

A preoperative ECG showed marked regression of previous changes due to healing of the infarction, and it was decided that it was proper to proceed with the contemplated cholecystectomy.

Accordingly, on May 6, 1954, with the patient under general anesthesia, a cholecystectomy was performed. The gall bladder was found to be chronically diseased and contained three faceted stones. The common duct was normal, and an operative cholangiogram disclosed no evidence of calculi.

His recovery was entirely uneventful; he was up and about by the third postoperative day and was discharged on the ninth postoperative day. Since then he has done well, having had neither digestive nor cardiac symptoms.

Serious Heart Disease Made Worse by Gallstone Disease.—F. B., a white woman, aged 53, was admitted to the service of Dr. I. S. Ravdin on Aug. 30, 1939. She was told that she had a "leaky heart" after peritonitis at age 25. She claimed that she had no very distressing symptoms until one and a half years previously, when she had an attack of palpitation associated with weakness which lasted several hours. At the same time she began to have attacks of "indigestion," associated with abdominal cramps and diarrhea, and pain in the upper abdomen radiating around to the right side of the back. Some of the attacks had been severe enough to require morphine, although minor attacks occurred every few days. Each of these attacks was followed by increased palpitation and weakness. There was no doubt in her mind that these symptoms were augmented, if they were not initiated, by attacks of abdominal pain. Her condition became such that her physician placed her on a program of restricted activity. She had never been decompensated.

She was found by Dr. Fitz-Hugh to have an old "rheumatic" mitral value disease (stenosis and insufficiency), with some myocardial degeneration, and extrasystolic arrhythmia, with episodes of auricular fibrillation. In addition, she was found to have gallstones.

Cholecystectomy was performed Sept. 6, 1939. After cholecystectomy she had three attacks of paroxysmal auricular fibrillation; then these attacks disappeared.

She still had heart disease, but 15 months after operation she remained greatly improved and was able to resume many of her previous activities. Although she still tired easily, attacks of "palpitation" occurred only at rare intervals and fibrillation had ceased.

From a life of chronic invalidism she improved so that she was able to take an active part in civic

affairs. A midwestern cardiologist had written her physician as follows: "If Mrs. B. is to live, she must be prevented from getting into the hands of a surgeon," and yet she lived until late in January, 1954, enjoying life until the end, which came after a fatal coronary occlusion.

Anginal Type.—S. L., a white woman, aged 48, admitted to the service of Dr. I. S. Ravdin on Feb. 23, 1940, had a history of attacks of severe precordial pain, occurring mainly at night but occasionally after meals and accompanied by palpitation and dyspnea. The precordial pain radiated through to the back and down the ulnar aspect of the left arm to the finger tips. After these attacks the patient noticed residual soreness of the precordium and paresthesias of the left forearm and fingers of the left hand. The pain was sometimes relieved by large doses of glyceryl trinitrate (nitroglycerin).

The attacks began about five years previously, six months after cholecystectomy was performed elsewhere. There was no history of jaundice, acholic stools, nausea, or vomiting. Until the last attack of pain, a few days before entering this hospital, the patient had no attacks of abdominal pain, all previous pain having been precordial in location. In spite of all previous therapeutic efforts, the attacks of pain became more severe and more frequent. A diagnosis of angina pectoris had been made in several other institutions, and left stellate ganglionectomy had been performed. No relief was afforded by this procedure; in fact, the patient's condition became much worse. Frequent attacks of pain were now brought on by the mildest exertion, even by eating. Many of the attacks came on at night while the patient was sleeping. She had lost 44 lb. (20 kg.) and had become practically bed-fast.

In December, 1939, she was first admitted to the Hospital of the University of Pennsylvania. At this time ballistocardiographic studies were made by Dr. Isaac Starr; they showed an abnormally low cardiac output, thought to be indicative of myocardial damage. Alcohol injection of the second, third, fourth, and fifth thoracic sympathetic ganglia on the left side was done at this time. The patient was discharged and readmitted Feb. 23, 1940. During the interim her condition had become steadily worse. A few days before readmission she experienced her first attack of definite abdominal pain. This pain was located high in the epigastrium and right upper quadrant. However, at this admission, it was thought by Dr. Wolferth that the electrocardiogram for the first time showed evidences of localized myocardial damage.

In view of the lack of results from previous therapy and because of definite suggestion of a biliary tract origin of the patient's complaints, exploration of the common bile duct was performed on March 22, 1940. A thick, kinked common duct was found, plastered with adhesions and containing some "sand" but no stones. The duct was freed of adhesions and thoroughly irrigated, and a T-tube was left in place. Shortly after operation the patient declared that she was free from attacks of pain. She found that she could eat liberally without fear of discomfort. She was soon out of bed and, for the first time in five years, was able to walk about freely without recurrence of pain. Ballistocardiograms made at this time showed a normal cardiac output.

On the eighth postoperative day studies of common duct resistance were made. At the first severe distention of the common duct the patient complained bitterly of precordial pain, radiating down the ulnar aspect of the left arm, entirely similar to her previous attacks. She was very upset and had to be reassured that these pains were entirely a product of the procedures and not a recurrence of her old condition. Distention of the common duct was repeated twice more on the same day, with exactly similar results. For several hours after the termination of these studies, the patient complained of residual soreness in the precordium and of numbness and paresthesias of the left arm and hand. Four days later the experiments were repeated, with similar results. Distention of the common duct was performed three times, and in each instance an anginoid attack was precipitated whenever the common duct pressure was raised to levels of 450 and 500 mm. of water. The severe precordial pain subsided promptly upon release of the high ductal pressure, leaving residual precordial soreness and paresthesias of the left arm and fingers of the left hand. Figure 4 illustrates the relationship between common duct pressures and the symptoms.

The patient was shortly afterward discharged, symptom-free.

Anginal Type.—J. F., a woman, aged 41, was admitted to the Hospital of the University of Pennsylvania on Jan. 5, 1939. She stated that at the age of 23, shortly after the birth of her first child, she began to have attacks diagnosed as gallstone colic. She was operated on one year later by the late Dr. John B. Deaver, and the gall bladder was found to contain multiple stones. After an uneventful postoperative course, she remained perfectly well and enjoyed excellent health until a year before admission. At this time, 17 years after operation, she began to have nocturnal attacks of severe pain in the precordial area and high up in the epigastrium. The attacks were so severe that the patient had a feeling of impending death. They were at times relieved by nitrites and always relieved by morphine.

From Jan. 3, 1938, until July 1, 1938, the patient had 48 such attacks. From Oct. 21, 1938, until the time of admission she had 22 attacks. No relation-

ship to either food or allergy was determined; the patient suffered no indigestion; she was never nauseated nor did she vomit. She never was jaundiced. While the attacks were almost always nocturnal, there seemed to be no relationship to the patient's activities.

The systolic pressure was 130, and the diastolic pressure was 80. The heart was not enlarged to percussion. There was a sinus arrhythmia. The remainder of the physical examination was essentially negative.

Her physician, an excellent cardiologist, had made the diagnosis of angina pectoris, and when it was suggested that she might have a stone in the common duct, he was loath to accept this diagnosis. He felt sure that if a stone had been in the common duct for 17 years the patient would have on previous occasions become jaundiced. The history of repeated nocturnal attacks of pain, coming on when the patient was at rest in bed, convinced us that this patient must have a stone in the common bile duct. Operation was therefore done on Jan. 7, 1939. One stone was found in the common duct. The postoperative course was uneventful. The wound healed normally, and the patient was discharged from the hospital on Jan. 23, 1939. She has remained perfectly well since that time and has never again had attacks of high epigastric or precordial pain such as those which occurred prior to her last operation.

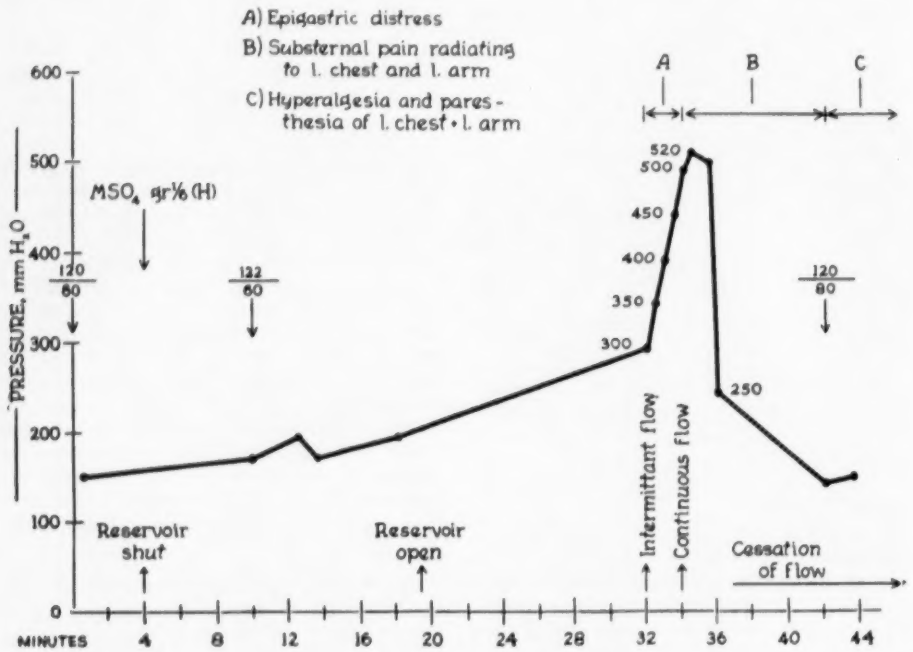

Figure 4.

COMMENT

The diagnosis of angina pectoris rests upon the closeness with which the symptoms conform to the classic criteria of Heberden, prompt relief by nitrites, and ECG and, possibly, also ballistocardiographic changes associated with the seizure. Patients with overt coronary disease may have pains closely resembling angina which may, in fact, be caused by something else. Gallstone disease is capable of producing localized spasm in the gastrointestinal tract. When this affects the esophagus, especially the lower part, the pain may be similar to that of angina pectoris. A patient subject to both angina and esophageal spasm may not be able to distinguish the two types of distress. Differential diagnosis is sometimes difficult and occasionally impossible.

The pains regarded as anginal in patients with gallstone disease are often unrelated to

effort and most frequently occur at night while the patient is at rest in bed. They frequently follow the eating of foods known to be poorly tolerated. Thus the diagnosis of angina pectoris must always be scrutinized carefully in patients with gall bladder disease, even when the diagnosis of coronary disease can be established and when the pain can be ameliorated by glyceryl trinitrate.

Nevertheless, there now seems little doubt that anginal pain can be excited in susceptible patients by gall bladder disturbances. Thus, when the diagnosis of angina can be made with reasonable certainty, its complete relief after operation may be interpreted as evidence that extrinsic factors originating in the diseased gall bladder had brought about narrowing of coronary vessels, lessening of coronary flow, and the precipitation of anginal seizures. Similarly, partial relief from anginal pain after surgery may be caused by removal of extrinsic exciting causes. The degree to which extrinsic factors, such as those originating in the gall bladder, might be effective obviously cannot be predicted prior to surgery, but the possibility of improvement should be considered.

Operation upon the biliary tract should not be undertaken solely for the purpose of relieving anginal pain unless evidence suggests a relationship between the biliary tract disease and the anginal seizures. On the other hand, the diagnosis of the anginal syndrome, even when established beyond reasonable doubt, should not be regarded as a contraindication to an operation upon a diseased biliary tract unless the heart disease is so far advanced that the operative hazard outweighs the chance of benefit. The cases reported above seem to us to indicate not only that symptoms simulating angina pectoris can disappear after biliary tract surgery but that, in at least some patients, true angina pectoris can be ameliorated or completely relieved.

We are now making a complete review of our patients from 1922 to the present with gallstone disease who have had any aspect of cardiac disease. We have thoroughly reviewed the first 25 years of this experience. During the period from 1922 to 1947, we operated on a total of 2100 patients with gallstone disease. Of these, 260 had one type of cardiac disease or another. This represents 12.4% of the entire group. It is interesting to review the operative mortality within this group. Ten of the 260 patients died while in the hospital, a mortality of 3.8%. In the period from 1922 to 1936, inclusive, there were 43 patients with cardiac disease, with 7 deaths—a mortality among the cardiac patients of 16.2%. From 1937 to 1944, inclusive, there were 111 patients with cardiac disease, with 3 deaths—a mortality of 2.7%. From 1944 to 1947, inclusive, there were 106 patients with cardiac disease, and no deaths occurred in this group. It can be seen that with improvements in preoperative and postoperative care, with better anesthesia, and with more careful control by competent internists and cardiologists, the mortality has continually been reduced. The risk is not as great as most clinicians believe it to be. However, it is important that the patient be surrounded by every possible safeguard in the period before, during, and after operation.

SUMMARY AND CONCLUSIONS

The relationship of gallstone disease and cardiac disturbances is reviewed. Several cases are presented to show the possible unfavorable reflex effects of biliary tract disease on existent heart disease. The symptom complex of pseudoangina as related to the stones in the gallbladder and/or common duct is discussed.

The pitfalls of differential diagnosis are reviewed, since these become exceedingly important when the question of operation is considered in these patients. It is emphasized that the best results will be obtained only through the closest cooperation between internist and surgeon in completely evaluating each individual patient. It is also demonstrated that, through such cooperation, many patients may be materially and, sometimes, even dramatically improved.

A preliminary review of 2100 consecutive biliary tract operations at the Hospital of the

University of Pennsylvania from 1922 to 1947 is included. This includes 260 operations on patients with cardiac disease. The over-all mortality within this group for 24 years was 3.8%. A breakdown of this mortality by periods has shown a marked reduction in more recent years. The results of this latter study will be presented in complete form in a subsequent paper.

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Retroperitoneal Rupture of Duodenum Following Nonpenetrating Injuries to Abdomen

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Rupture of the retroperitoneal portion of the duodenum is not a frequent occurrence, but it does occur sufficiently often to be of clinical significance to those interested in the surgery of this area. Owing to the fact that such an injury frequently gives little evidence of its presence on routine exploration of the abdomen, the possibility of such an injury being present must be constantly borne in mind to prevent its being overlooked. In the hands of competent and experienced surgeons, failure to recognize such injuries has been reported, and this is particularly liable to occur when injuries to other structures are found which are thought sufficient to account for the patient's symptoms.

The duodenum is well protected from most types of abdominal assault, but, owing to its having a fixed position as it passes in front of the vertebral column, it is particularly vulnerable to compression injuries, such as those that occur when a person is thrown violently against the steering wheel of an automobile or when he is severely squeezed in this area from any cause whatsoever. Less severe types of trauma, such as being kicked in the epigastrium when the muscles are relaxed, striking the abdomen against an object during a fall, or even receiving a severe blow on the back, may result in rupture of the duodenum. The symptoms resulting from such an injury at first may be minimal. However, with extravasation of duodenal contents and as digestion of retroperitoneal tissues become more extensive, pain, tenderness, and rigidity of abdominal muscles, fever, and leucocytosis increase. The decision to explore the abdomen of a person suspected of having an injury to the duodenum or surrounding structures rests largely on the history of the type of injury sustained and the findings from clinical examination. X-ray investigation may be informative and an aid in diagnosis, but it is probably rarely of sufficient significance to be a deciding factor in the handling of such cases. Obscuring of the ileopsoas outline or the demonstration of pockets of air in the retroperitoneal tissues may, on rare occasions, be of considerable significance. The oral administration of radiopaque solutions to demonstrate leakage from the duodenum is favored by some physicians but objected to by others. We have had no personal experience with this method of diagnosis. The finding of an elevated blood amylase value is evidence that there has been an associated pancreatic injury and would further strengthen the indications for abdominal exploration. While other evidence may be accumulated to indicate that there has probably been an intra-abdominal injury, the final decision for surgical exploration will almost invariably depend upon abdominal pain, tenderness, and muscle rigidity. Whenever an exploratory operation is done on an abdomen in which intra-abdominal injury is suspected, a systematic method of procedure should always be employed in order that injuries are not overlooked. The duodenum is the most difficult intra-abdominal organ to explore accurately because of its being almost entirely retroperitoneal and surrounded by important structures that prevent its easy visualization. No exploration of the abdomen is complete unless the condition of the duo-

denum has been established. The presence of a retroperitoneal hematoma in the region of the duodenum calls for close scrutiny of this organ, and the finding of bile, as shown by a greenish-yellow discoloration to the tissues, is prima facie evidence that a duodenal injury has occurred. In order to explore the duodenum, an incision should be made through the posterior peritoneum just lateral to its descending portion. By retracting the duodenum and head of the pancreas upward and medially, most of the duodenum can be visualized. Further exploration can be accomplished by lifting up the transverse colon and incising the posterior peritoneum to the right of the root of the mesentery of the small intestine, and, if necessary, the terminal part of the duodenum may be approached by incising the peritoneum in the region of the ligament of Treitz. The presentation and discussion of the problems arising during the handling of two cases of duodenal injury will further emphasize the important points to be remembered when one is confronted with such injuries.

REPORT OF CASES

Case 1.—A Japanese boy, aged 13, was first seen on July 23, 1949, 20 hours after injury. He was running down the highway when he stumbled and fell, striking his abdomen against the curbing. Immediately after injury, symptoms were minimal, but abdominal pain of increasing severity developed.

On examination there was acute pain and tenderness, with muscle rigidity, most marked in the right lower quadrant. The temperature was 100 F, and white blood cell count was 15,250, with 90% polymorphonuclear leucocytes. Urine examination was negative. A flat x-ray plate of the abdomen showed obliteration of the edge of the right ileopsoas muscle, and the radiologist called attention to a speckled appearance in the right midquadrant which had the appearance of subcutaneous emphysema. It was our feeling that we were dealing with an intra-abdominal injury, and immediate exploratory laparotomy was performed.

A long right rectus incision was made. Bile-stained bloody fluid was found extraperitoneally, having dissected its way up over the dome of the urinary bladder. Intra-abdominally, there was no free blood or bile and no evidence of injury to the liver, spleen, or gastrointestinal tract. There was a large retroperitoneal tumor in the region of the right kidney which, upon exploration by incision of the peritoneum lateral to the descending colon, was found to consist of blood, bile, and, undoubtedly, pancreatic secretion. The dissection was carried over to the retroperitoneal portion of the duodenum. There was a perforation in the posterior wall of the third portion of the duodenum approximately 2 cm. in diameter. This opening was closed with several layers of interrupted fine nonabsorbable surgical (silk) sutures and the area reinforced by covering it over with omentum. Since there had been extensive extravasation of bile-stained bloody fluid all the way into the pelvis, multiple soft rubber tissue drains were introduced extraperitoneally into these areas as well as to the site of the original injury. The patient was given several blood transfusions during and after operation, as well as other intravenous fluids. Constant Wangensteen suction was maintained for 72 hours, and adequate amounts of penicillin and streptomycin were administered. There was no leakage from the site of the duodenal repair, and we were surprised at the lack of infection and suppuration in the retroperitoneal area.

The patient made a satisfactory recovery and was discharged from the hospital on the 15th postoperative day.

Case 2.—T. A., a Chinese-Hawaiian man, aged 39, was seen with Dr. H. M. Chandler, at Waipahu Hospital, on Feb. 12, 1952, approximately three hours after injury. He had been standing in front of a stationary object when he was struck from in front across the upper abdomen by a backing-up truck, thereby sustaining a severe compressing force to his abdomen. The patient complained of moderate abdominal pain. He showed no evidence of shock.

Examination revealed an area of acute tenderness in the epigastrium and to the right of the umbilicus. There was marked muscle rigidity in this area. X-ray examination of the abdomen showed nothing abnormal. An exploratory operation of the abdomen was believed advisable, as we thought that probably we were dealing with a ruptured liver or duodenum or injury to some other viscus.

With the patient under spinal anesthesia, reinforced by general anesthesia, a paraumbilical right rectus, muscle-splitting incision was made. There was no blood or other signs of contamination in the abdominal cavity. The liver, colon, stomach, and small intestine showed no evidence of injury. There was a large retroperitoneal hematoma in the region of the duodenum. This area was explored by an incision in the peritoneum to the lateral side of the descending duodenum and by opening the peritoneum posteriorly below the transverse colon. After clearing away the blood clots, the picture shown in Figure 1 was found. There was a rent in the duodenum below the ampulla of Vater, with extensive trauma above and below this opening.

The head of the pancreas had been almost completely severed, leaving a small strip of the gland attached to the duodenum. The duodenum seemed to be too badly traumatized to permit its being repaired. An attempt was made to locate the pancreatic ducts, but interstitial hemorrhage and edema prevented their identification. The duodenum was removed from just beyond the pylorus to the beginning of the jejunum. The jejunum was brought through the mesocolon and anastomosed to the stump of the duodenum that had been left attached to the pylorus. The common bile duct was implanted into the jejunum. The head of the pancreas was sewn over, with the use of two rows of Atraumatic chromic absorbable surgical (gut) sutures and covered over with omentum brought through the mesocolon (Fig. 2). The region of the head of the pancreas was drained through a stab wound to the right of the incision. During the operation, the patient received 1,000 cc. of blood, and his condition at the completion of the operation was satisfactory.

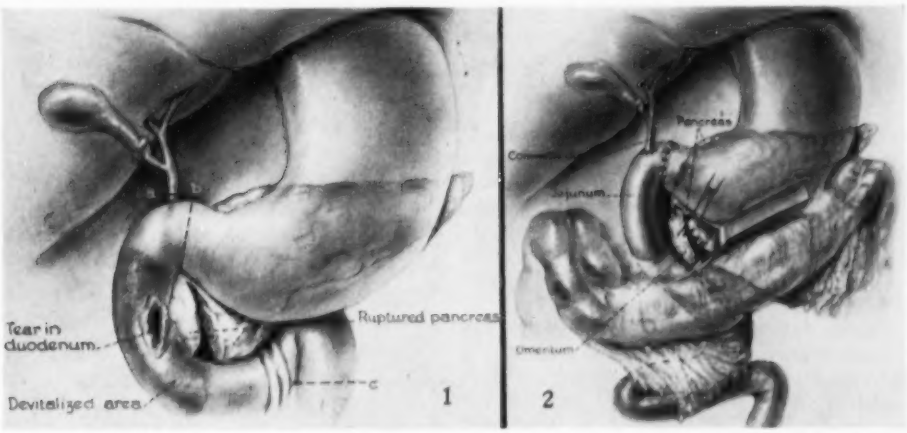

Fig. 1.—Extent of injury to duodenum and head of pancreas. Common duct severed at *A*, pylorus at *B*, and jejunum at *C*.

Fig. 2.—Anastomosis of the jejunum to the pylorus, the implantation of the common duct into the jejunum, and the injured pancreas being covered by omentum.

On March 5, 1952, 21 days after surgery, the patient was transferred to The Queen's Hospital with signs of pyloric obstruction manifested by epigastric pain, nausea, and vomiting. He lost approximately 16 lb. (7.3 kg.) in the three weeks after injury. He continued to drain about 1 liter of thin milky fluid through his abdominal incision. He complained of severe generalized weakness. Several hours before admission, he had vomited blood, and within a few hours after entry into the hospital he had a tarry stool. The red blood cell count was 4,120,000, with 9.7 gm. of hemoglobin on entry. He was listless, pale, and weak. His blood pressure was 80/62. There was a moderate amount of irritation of the skin about the fistulous tract owing to digestion by the pancreatic juice. During the first week of hospitalization, the patient received 2.5 liters of whole blood, 2 gm. of potassium chloride daily, and 5 to 10% dextrose in 1000 cc. lactate Ringer's solution intravenously. An attempt to feed him a high-carbohydrate high-protein low-fat diet was unsuccessful because of repeated vomiting, so continuous Wangensteen suction was started. An x-ray of his stomach five days after entry, March 10, 1952, taken three hours after ingestion of barium, revealed 100% gastric retention, secondary to obstruction at or near the pylorus. At time of entry, he was thought to be in metabolic acidosis, and this was confirmed by our finding blood sodium to be only 97 mEq. per liter. This was due to considerable loss of fluid through the pancreatic fistula as well as the result of the vomiting shortly before entry.

On March 13, after one week of hospitalization, he still required continuous Wangensteen suction because of inability of food or of any appreciable amount of liquid to pass the pylorus. He continued to lose weight; he remained apathetic and weak and continued to drain a large amount of pancreatic juice through his abdominal fistula. Over a 24-hour period on March 13, he lost 1350 cc. of pancreatic juice in the fistula, 1200 cc. of gastric juice by the Wangensteen suction, and 700 cc. of urine, making a total of 3250 cc. Blood studies on this date revealed a sodium level of 135.8 mEq. per liter; potassium, 4.6 mEq. per liter; HCO_3, 32.8 mEq. per liter, and chloride, 93 mEq. per liter.

The packed cell volume was 52 ml. per 100 cc. The 24-hour loss of electrolytes was as follows:

Pancreatic juice: sodium, 160 mEq.; chloride, 126 mEq.; potassium (estimate), 7 mEq.

Gastric juice: sodium, 23 mEq.; chloride, 52 mEq.; potassium (estimate), about 12 mEq.

Urine: sodium, 20 mEq.; chloride, 12 mEq.; potassium, 30 mEq. per 24 hours.

His weight was about 50 kg., and his normal extracellular fluid volume was about 10 liters. The 24-hour loss of electrolyte then was as follows:

Sodium: 160 mEq. from pancreas + 23 mEq. from gastric juice + 20 mEq. from urine = 203 mEq. per 24 hours.

Chloride: 126 mEq. from pancreas + 52 mEq. from gastric juice + 12 mEq. from urine = 190 mEq. per 24 hours.

Potassium (estimate): 8 mEq. from pancreas + 12 mEq. from gastric juice + 30 mEq. from urine = 50 mEq. per 24 hours.

These studies indicated that the initial metabolic acidosis had been slightly over-corrected, giving a mild metabolic alkalosis, with slightly low sodium and chloride and with slightly high bicarbonate. Although blood volume was not determined, it was estimated that there was a total electrolyte deficit of about 2 or 3 liters of fluid with decreased blood volume.

During the next 24 hours, replacement therapy consisted of the administration of 7.725 liters of fluid as follows: 3 liters of 10% glucose in isotonic sodium chloride solution and 4.725 liters of fluid given through the gastric tube in the form of the pancreatic juice recovered from the fistula by suction plus a high-calorie formula. At the end of this 24-hour period, the patient's urinary output had increased to 1250 cc. in spite of loss of 5.4 liters by Wangensteen suction. He began to retain fluid by mouth when the Wangensteen tube was clamped off, and, by March 17, x-ray of the stomach five hours after an oral administration of liquid barium disclosed that only 10% was retained in the stomach. From this point on, the drainage from the pancreatic fistula gradually decreased; he began to gain weight and completely lost his weakness and apathy, and, on April 16, he was discharged from the hospital. He was placed on methantheline (Banthine), low-fat diet, and pancreatin.

Now, more than two years after the injury, he is working six days a week plus overtime as a construction foreman, besides in his free time running a farm. His weight is 66 kg. (146 lb.), in contrast to 50 kg. (110 lb.) at the time of hospitalization. He has one bowel movement a day, which varies from a rather normal-appearing stool to a very fatty stool with gross fat dependent upon the amount of pancreatin tablets he takes and the amount of fat in his diet. He has eaten essentially the same diet he had before the injury except for reduction in fried foods and butter. He takes 3 to 5 0.3-gm. pancreatin tablets immediately after meals, varying the dose himself with the amount of fat he has at mealtime. He has no symptoms referable to his stomach. In fact, his only symptom in addition to fatty stool has been a mild acneform rash of his face, which has appeared since the injury. An upper gastrointestinal series on Dec. 15, 1952, revealed a well-functioning gastrojejunal anastomosis, without evidence of pyloric obstruction. Various laboratory procedures done during the past year have been within normal limits, except for the presence of increased fat in stools, decreased fecal amylase activity, and a slightly high glucose-tolerance curve, reaching 249 mg. per 100 cc. one hour after ingestion of 100 gm. of glucose but returning to low normal (71 mg. per 100 cc.) three hours after ingestion of the glucose.

COMMENT

The conduct of repair and postoperative care of a person so severely injured, as depicted in Case 2, taxes the surgeon's judgment and operative skill and imposes changes in physiological functions needing careful attention to insure a successful outcome.

In recent years, considerable clinical experience has been accumulated regarding the physiology of the pancreas after resection or complete removal of this organ in dealing with neoplasms and various types of pancreatitis. It has been shown that the diabetic state is not usually produced unless 90% of the pancreas is removed and, for some unaccountable reason, diabetes after total pancreatectomy is frequently easier to control than it is in patients with diabetes not resulting from surgical removal of this gland. In one patient after pancreatectomy, the insulin requirements were only 10 units of regular and 10 units of protamine zinc insulin daily.[1] In another patient in whom the pancreas was removed for chronic pancreatitis with calculi, followed for two years only, 20 units of protamine zinc insulin was required daily, even though the caloric intake was as much as 5,000 to 6,000 Cal. per day.[2]

There has been considerable difference of opinion regarding the desirability of attempting to preserve the external secretion of the remaining portion of the pancreas after its resection. Majority opinion favors such an attempt either by direct anastomosis of the pancreatic ducts with the jejunum, or, when this is not feasible, by insertion of the end of the pancreas into the open end of the jejunum. We have used both methods successfully. Brunschwig,[3] at the meeting of the American Surgical Association, in 1952, stated that he was not convinced that preserving the external secretion of the pancreas was desirable or even advisable, and he makes no effort to preserve this function of the pancreas.

In the case presented here, identification of the pancreatic ducts was impossible, and it hardly seemed feasible to attempt implantation of the head of the pancreas directly into the jejunum. The patient's subsequent course indicates that he is able to maintain a fairly normal metabolism without the external pancreatic secretion being preserved, by oral ingestion of pancreatin.

The use of pancreatin in persons who have lost the external secretion of the pancreas, in our experience and in the experience of others, has been found to be of decided value in aiding the metabolism of fat.[3] It seems to exert a less favorable effect in improving nitrogen balance.[4]

After radical duodenopancreatectomy and in cases in which the duodenum was sacrificed, it would seem desirable to resect the greater portion of the stomach in order to prevent an anastomotic ulcer. The incidence of such ulcers after the anastomosis of the jejunum to an intact stomach in persons without a duodenal ulcer diathesis is not known. However, such a complication has occurred in our experience.

In Case 2, anastomosing the jejunum to the pylorus in the absence of alkaline pancreatic secretion into the intestinal lumen would seem to make this possibility even more likely. This may have occurred, since the patient developed temporary pyloric obstruction and vomited blood on the 21st postoperative day. Perhaps the introduction through the Levin tube of recovered pancreatic secretion may have helped to overcome this beginning complication. The common duct was anastomosed to the jejunum near the pylorus to help prevent such an occurrence by flooding the area with alkaline bile. At the time of surgery, we did not feel justified in adding an extensive gastric resection to an already major procedure when the possibility of a stomal ulcer developing was so uncertain.

In conclusion, we wish to emphasize the necessity of exploring the region of the retroperitoneal portion of the duodenum in cases of suspected intra-abdominal injury. Particularly is this advisable when the patient has received a severe compressing force to the upper part of the abdomen. A case of combined injury to the duodenum and pancreas is presented that illustrates the extensiveness of repair that may be necessary after such injuries and the complicated postoperative metabolic disturbances that may arise which need correction if a successful outcome is to be expected.

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The Incidence of Postoperative Pancreatitis

Study of One Hundred Thirty-One Surgical Patients, Utilizing the Serum Amylase Concentration

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An elevation in the concentration of serum amylase following abdominal trauma or in the presence of acute abdominal symptoms is considered a reliable indication of pancreatic injury or disease. Recent studies of the plasma amylase concentration following battle injury have suggested that pancreatitis may result not only from direct injury to the pancreas but also as a result of indirect trauma, such as the transmission of force from a missile passing near the pancreas, injury at the time of surgery, or subsequent bacterial injury.[3]

On the basis of a study of the urinary amylase in 147 patients after subtotal gastrectomy, Millbourn [4] reported an incidence of acute pancreatitis of 9%. In 6 of the 13 patients developing pancreatitis, the disease was subclinical; in 5 patients the disease was severe, causing the death of 2. The author blamed the complication on injury to the accessory pancreatic duct (Santorini). Warren,* emphasizing that pancreatic necrosis constituted the most serious complication of gastric surgery, reported seven fatalities. He was unable to explain the etiology of the complication. Dunphy and his associates [2] reported eight patients with acute postoperative pancreatitis. In two fatal cases, the complication followed an operation on the biliary tract which included dilatation or division of the sphincter of Oddi. In three of their eight patients pancreatitis followed subtotal gastrectomy.

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* References 7 and 8.

After production of appendiceal peritonitis in dogs, Nemir and co-workers [5] found an increase in the serum lipase concentration but no significant rise in the amylase concentration. Nevertheless, they believed that the increased lipase concentration reflected peripancreatic and interlobular inflammation.

The purpose of the present study was to extend the study of the incidence and significance of acute pancreatitis in the immediate postoperative period.

Incidence of Acute Pancreatitis in the Postoperative Period

Type of Operation	Patients, No.	Amylase Concentration Above 80 Units (Normal 15-40 Units)	
		Patients, No.	Patients, %
Abdominal:			
Subtotal gastrectomy...	20	3	15
Biliary tract procedure..	30	2	7
Gynecological procedure.	8	0	0
Lumbar sympathectomy	8	2	25
Other intra-abdominal operations	34	2	6
TOTAL—Abdominal operations	100	9	9%
Controls:			
Thyroidectomy	5	0	0
Thoracic operations.....	8	0	0
Amputations	2	0	0
Herniorraphy	16	0	0
TOTAL—Control operations	31	0	0

MATERIAL AND METHODS

One hundred and thirty-one patients on the general surgical service were selected for study. Most of the patients had chronic diseases. The types of operations required are listed in the Table; 100 patients had intra-abdominal procedures, and 31 had operations other than laparotomy.

Amylase determinations were done by the method of Wohlgemuth as described by Bray.[1] This method is described as giving

a normal range of the serum amylase concentration of 15 to 40 units (mg. per 100 cc. of glucose formed by the incubation of serum with starch). In a series of 70 controls in our laboratory, the normal concentration occasionally was noted to be as high as 50 units. The concentration was usually determined preoperatively and 1, 24, 48, and 72 hours postoperatively, but complete uniformity in the timing of the samples was sometimes lacking. Blood was centrifuged; the serum was separated immediately and placed in a deep freeze. Freezing has been shown to have no significant effect on amylase activity.[3]

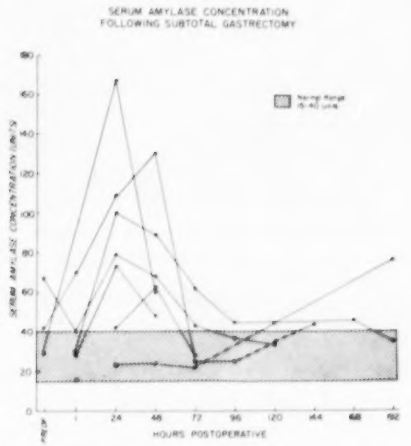

Fig. 1.—Demonstrating a striking elevation in serum-amylase concentration in six patients. The patient with the high amylase concentration preoperatively had a marginal ulcer with a subacute perforation into the pancreas.

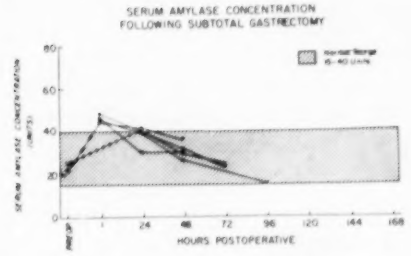

Fig. 2.—In five patients, the amylase concentration was slightly elevated for a brief period. This may have resulted from pancreatic manipulation.

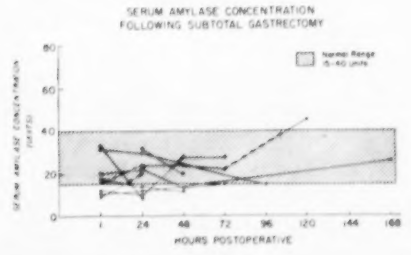

Fig. 3.—In the absence of pancreatic injury, many patients developed a very low amylase concentration.

RESULTS

The results of the study demonstrated a striking incidence of pancreatitis following abdominal surgery and, particularly, after upper abdominal operations.

Subtotal Gastrectomy.—Of the 20 patients studied after subtotal gastrectomy, 7 (35%) demonstrated a distinct elevation in the serum amylase concentration (Fig. 1). The amylase concentration increased to at least 100% above normal in three of these patients. The maximum concentration was reached about 24 hours after operation. After 24 to 48 hours, the concentration returned toward normal. An additional five patients demonstrated transiently a concentration which was slightly elevated (Fig. 2). In this group the concentration fell rapidly to lower limits. In the remainder of the patients the serum amylase activity decreased, sometimes almost disappearing (Fig. 3).

Biliary Tract Procedures.—Thirty patients were studied after biliary tract operations (cholecystectomy, cholecystostomy, choledochostomy, and cholecystojejunostomy). Two of these patients had subsiding pancreatic disease with an amylase concentration which was slightly elevated prior to operation (Fig. 4). Excluding these two patients because the operation might not have been the precipitating factor, four patients demonstrated a distinct rise in the amylase concentration above 50 units after operation, and five patients had less striking elevations in amylase level. One patient underwent cholecystectomy, biopsy of the liver, and a careful dissection of the lesser curvature of the

stomach in a search for a diverticulum or ulcer which had been noted on roentgenograms. One hour later, his serum amylase concentration was 95 units, and it remained elevated for 72 hours. Another patient with a choledochoduodenal fistula due to a duodenal ulcer had choledochostomy with intubation of the sphincter of Oddi and subtotal gastrectomy. Her amylase concentration remained high for several days. She was critically ill for the first four days after operation and then improved until the seventh day, when the duodenal stump developed a leak. Figure 5 demonstrates the pattern in the seven patients following choledochostomy. In addition to two

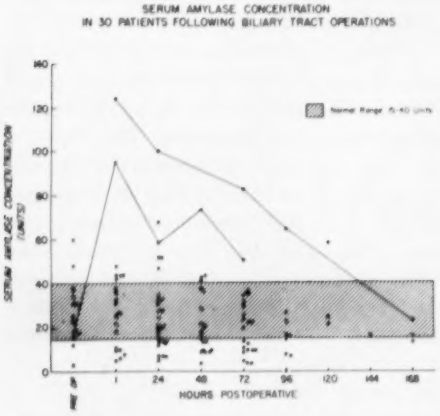
SERUM AMYLASE CONCENTRATION
IN 30 PATIENTS FOLLOWING BILIARY TRACT OPERATIONS
SERUM AMYLASE CONCENTRATION (UNITS)
HOURS POSTOPERATIVE

Fig. 4.—Demonstrating the response to biliary-tract surgery. Two of these patients had preoperative values which were slightly high owing to subsiding pancreatic disease.

patients who developed a distinct rise, all except one of the others had an amylase concentration which was slightly above normal or at the top of the normal range.

Gynecological Procedures.—Eight patients were studied after gynecological operations: hysterectomy (6), ectopic pregnancy (1), and perineal repair (1). No patient demonstrated an amylase concentration higher than 51 units.

Lumbar Sympathectomy.—Of seven patients undergoing bilateral lumbar sympathectomy for peripheral vascular disease, one (*A*) developed a striking elevation in amyl-

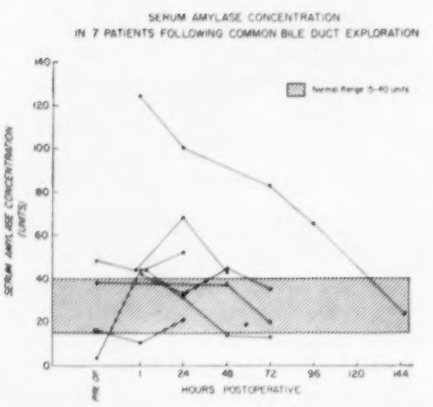
SERUM AMYLASE CONCENTRATION
IN 7 PATIENTS FOLLOWING COMMON BILE DUCT EXPLORATION
SERUM AMYLASE CONCENTRATION (UNITS)
HOURS POSTOPERATIVE

Fig. 5.—Following choledochostomy, the amylase concentration tended to rise.

ase concentration (Fig. 6). This patient had an amylase concentration of 130 units one hour after the resection of the 12th thoracic and the four lumbar ganglia. This was the only patient who had the 12th thoracic and 1st lumbar ganglia removed. An eighth patient (*B*) had, in addition to a bilateral lumbar sympathectomy, resection and replacement of a previously inserted aortic graft. His serum amylase, which had been 47 units preoperatively, rose to 156 units one hour postoperatively and remained elevated for the next 48 hours, with values of 112, 67, and 107 units being obtained during this period.

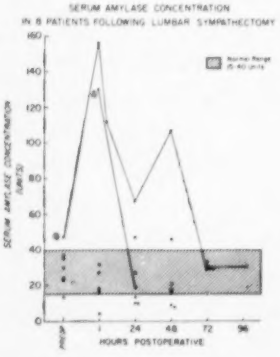

Fig. 6.—Two patients had a striking elevation. One of these patients is included in the graph for anatomical considerations although his principal operation was resection and graft of a segment of the aorta.

Other Abdominal Procedures.—Thirty-four additional patients were studied after operations including abdominoperineal resection, appendectomy, colectomy, colostomy, splenectomy, repair of hiatal hernia, and exploratory laparotomy following penetrating wounds. One patient (*A*), after appendectomy for perforation and peritonitis, exhibited an elevated amylase concentration of 70 and 100 units on the second and third days respectively. Another patient (*B*) had a bullet wound of the duodenum, jejunum, and colon. A secondary operation on the second day included the division of the ligament of Treitz and the repair of an additional duodenal perforation. After the secondary operation, the amylase concentration rose to 78 units. The concentration was still elevated when last checked on the eighth day. The patient died of a duodenal fistula. Autopsy revealed extensive pancreatic necrosis. Three other patients (Fig. 7) developed similar increases in their amylase concentration after respective operations of palpation of the pancreas during a negative laparotomy, exploration of the pancreas because of a nearby penetrating wound (*C*), and resection of a gangrenous section of small bowel.

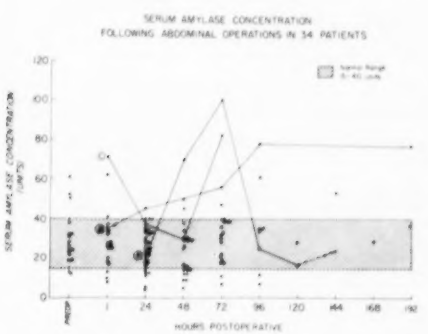

Fig. 7.—The most pronounced elevations occurred after appendectomy for perforation and peritonitis (*A*), bullet wound of the upper abdomen with a resulting duodenal fistula (*B*), and in a bullet wound adjacent to the pancreas (*C*).

Operations of the Neck, Chest, Body Wall, and Extremities.—Thirty-one patients were studied after thyroidectomy, thoracotomy, herniorrhaphy, and amputation. Only one patient demonstrated a distinct elevation in the amylase concentration. This patient showed a rise from 35 to 71 units after the transthoracic repair of an achalasia. Neither gastric traction on the pancreas nor subsequent peritoneal infection was suspected clinically.

COMMENT

Just as in the study of acute pancreatitis of the usual "spontaneous" type, amylase determinations indicate that pancreatitis following operation is much more frequent and often less severe than was appreciated when autopsy findings constituted the chief basis for study. Only 1 of the patients in this study died; yet 27 developed an amylase concentration of 50 units or more, and 9 of these had a concentration of more than 80 units. To date, the role of peritonitis in producing a secondary pancreatitis is not evident. The incidence of pancreatitis in this series following surgery of the duodenum strongly suggests that the complication rests on a mechanical basis. The severer forms of postoperative pancreatitis can easily be correlated with the patient's postoperative course, but as yet the milder forms cannot. In order to further clarify the syndrome, duodenal surgery, including major common-duct operations, must be followed routinely by serial serum-amylase determinations. Such a study is of aid not only on an investigational basis but also in explaining the complications encountered in clinical surgery.

Many of the patients with operations distant to the pancreas developed a low amylase concentration, a finding suggestive of the stress response.[3]

SUMMARY

A study of serum amylase concentration in 131 postoperative patients indicates that acute pancreatitis or pancreatic injury is a frequent complication of upper abdominal surgery.

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Extraosseous Adamantinoma

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Adamantinomas are tumors commonly thought to arise in the mandible alone and to be of dental interest only. However, it is now well known that they occur in other bones and often are a problem of the surgeon rather than the dentist. Their appearance in the tibia, ulna, radius, and maxilla is well documented.* The neurosurgeon not infrequently sees them in the pituitary gland [14] (craniopharyngioma). But as extraosseous tumors, occurring in soft tissue with the underlying bone normal, they become a clinical oddity. Interest was stimulated in this form by a patient who was recently treated for a huge oral tumor, completely free of bony attachments, which on pathologic examination proved to be an adamantinoma.

Approximately 80% of adamantinomas are found in the mandible, 15% in the maxilla, and the rest scattered through other skeletal or soft part structures. According to Chont,* Thoma,† and others,‡ adamantinomas may arise from several sources: from oral surface epithelium which retains the potential ability to specialize into ameloblast, from mucous glands of oral epithelium, from epithelial inclusions along the teeth, the primitive enamel anlage of a degenerated follicle, from odontogenic cysts, and from displaced epithelium in other parts of the body. Basal cell origin was first reported by Krompecher [12] and Bakay,[2] and Broders and MacCarty [5] have noted its marked cellular resemblance and close relationship to the squamous cell epithelioma. Cahn [6] believes that the tumor is essentially "an intraosseous basal cell epithelioma."

In view of the fact that many of these tumors arise from oral surface epithelium, it is surprising that they always are firmly attached to bone or grow within bone. Indeed, infiltration of the soft tissue is not a characteristic of the tumor. L'Esperance § reported three cases with soft tissue infiltration, one in the mandible and two in the maxilla, all, however, attached to bone. That this does not have to be so is supported by previous reports ‖ of extraosseous adamantinomas occurring within the oral cavity and also by the report of Zawewloschin,[20] who found one in the ovary of an 8-year-old girl, presumably associated with an ovarian teratoma.

Adamantinomas are slowly growing tumors and distend the bone rather than destroy it. When they originate in the maxilla, extension into the antrum, nose, and orbit is merely a matter of time, and its presence should be considered in patients with tumors in these areas.[11] Malignant change does occur, though it is rare, and there are not infrequent reports of lymph node and lung metastasis.¶ Because of their silent course and lack of pain many attain great size before treatment is instituted. The present report is of interest not only because of the extraosseous nature of the tumor, but because its tremendous size presented a problem in surgical removal.

REPORT OF A CASE

Mr. W., a 56-year-old white man, was first seen at the Veteran's Administration Hospital, Oakland, Calif., in April, 1953. He had been treated in the dental department for extraction of the last few remaining incisor teeth on his lower gum and had been referred to the Tumor Board because of a

From the Department of Surgery, Stanford University School of Medicine, and the Veterans Administration Hospital, Oakland, Calif.

* References 13 and 15.

† References 17 and 18.

‡ References 3, 6, 15, and 5.

§ L'Esperance, Elsie, quoted by Thoma, references 17 and 18.

‖ References 4, 7, and 9.

¶ References 16, 10, 19, 8, 17, and 18.

Fig. 1.—Preoperative photograph of patient showing huge intraoral tumor.

huge oral tumor which filled the entire mouth (Fig. 1). It was situated in such a manner that it did not impair breathing, swallowing, or speaking. The tumor was attached superiorly to the soft palate and laterally to the posterior margin of the left buccal mucosa. The remaining borders hung free within the oral cavity. The inferior border, which approximated the tongue, was hollowed out and scarred from continual action of the tongue and food particles. It extended backward to the posterior pharyngeal wall; in front it reached the upper gum. Each lateral border extended outward to the cheeks. In order to make room within the mouth for so large a tumor, the entire tongue was depressed, causing outpouching of the submental and submaxillary triangles, giving the face an exaggerated and elongated appearance (Fig. 2). The tumor was slightly movable and unattached to the hard (maxilla) palate. An examining finger could be passed freely, but with difficulty, between the tumor and the hard palate back to its attachment to the soft palate and left buccal cheek.

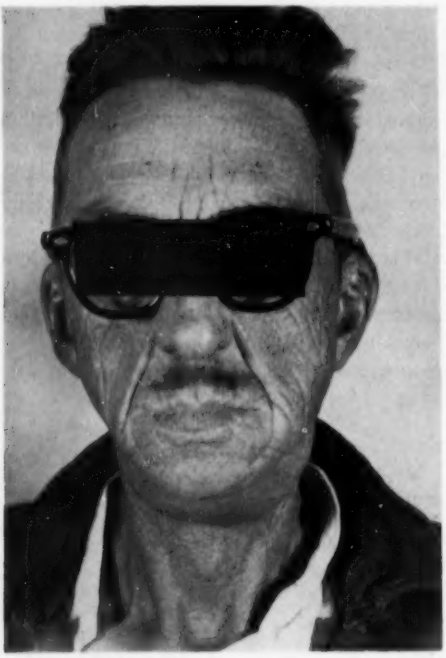

Fig. 2.—Photograph showing large outpouching of submental and submaxillary triangles, giving an elongated facial appearance.

Close questioning revealed the astounding history that the tumor had been present since birth. It had never given any symptoms, had grown progressively with the patient, and never interfered with swallowing or eating. The patient had resisted all efforts on the part of the medical profession to remove it, with the exception of an unknown amount of x-ray therapy, given without any effect, about five years previously.

The patient was not seen again until December, 1953, when he reported a sudden increase in size of the tumor. He was still able to carry out normal oral functions, but it was evident that the margin of compatibility was narrowing. Surgical removal was advised and this time accepted. X-ray studies of the bones of the face and head revealed no bony involvement. There were no other pertinent findings on physical examination.

COMMENT: Removal presented a problem not only because of the size of the tumor, but also because it was felt that it may be highly vascular, and, therefore, adequate exposure would be necessary to remove it safely. To do this, mandibular division was decided upon at a site close to the attachment of the tumor to the left buccal mucosa. In addition, when mandibular division or resection is contemplated in extensive operations involving the head and neck, an initial tracheostomy is mandatory. Anesthesia may then be given through the tracheostomy tube, thus assuring the anesthesiologist of a patent airway and complete control of the patient. Postoperatively serious sequelae from hemorrhage or edema of the pharynx and larynx with obstruction of the glottis can be managed easily, in addition to the advantage in preventing massive atelectasis from aspiration of oral or tracheal secretions. Once this important phase of the operation is completed, extensive surgery of the head and neck can be performed with relative safety.

Operation.—A tracheostomy was performed initially and anesthesia given through the tracheostomy tube (Fig. 3). A No. 6

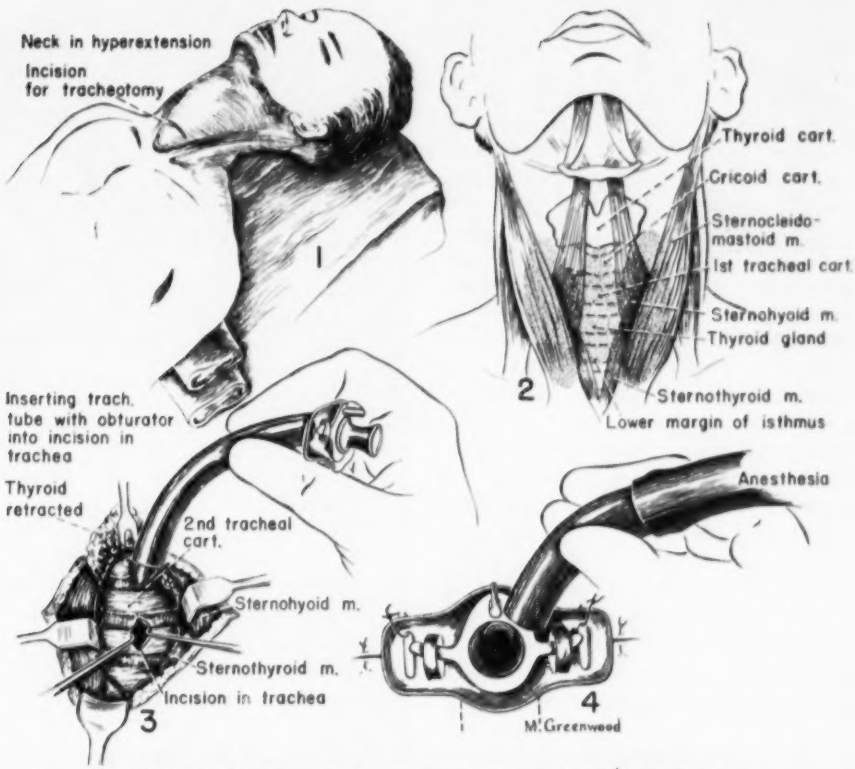

Fig. 3.—Technique of tracheostomy and method of giving anesthesia.

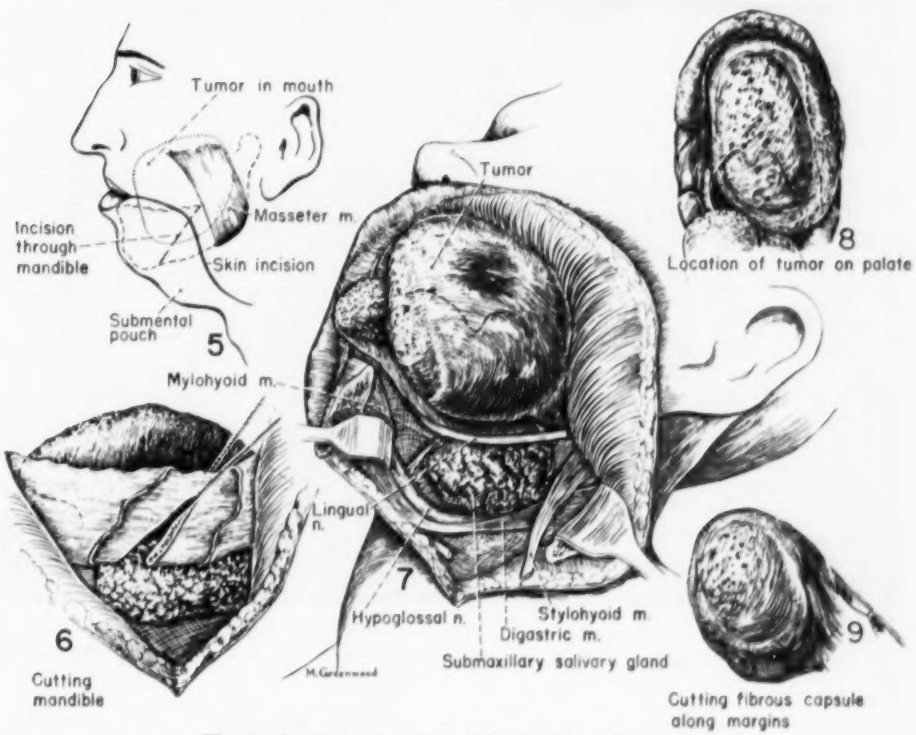

Fig. 4.—Surgical approach used for resection of the tumor.

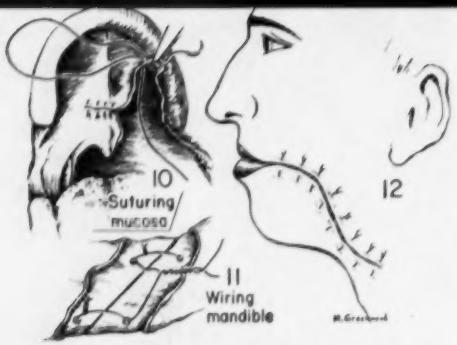

Fig. 5.—Closure following resection of the tumor.

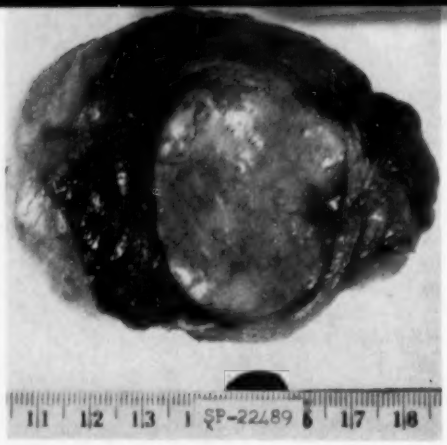

Fig. 7.—Photograph of the excised specimen.

tube is used for most adults. Figures 4 and 5 show the procedure which followed. The left cheek was divided at the commissure of the mouth and an incision made across the mandible well anterior to the masseter muscle. The only nerve which was cut was the marginal mandibular branch of the facial nerve. The mandible was divided diagonally and in the manner shown so that in closing the pull of the submental muscles draws the anterior segment downward, against the pull of the masseter and pterygoid muscles, which pull the posterior segment upward, thus aiding in proper apposition of the divided ends of bone. The mandibular segments were spread, exposing the entire oral cavity and tumor. By retracting the tongue and submaxillary salivary gland downward, the vital hypoglossal and lingual nerves were protected. The mucosa at the attachment of the tumor on the left buccal cheek and soft palate was incised. There was no bony attachment, and the tumor was easily removed across clamps. The mucosal edges were sutured together, the mandible wired, and the skin

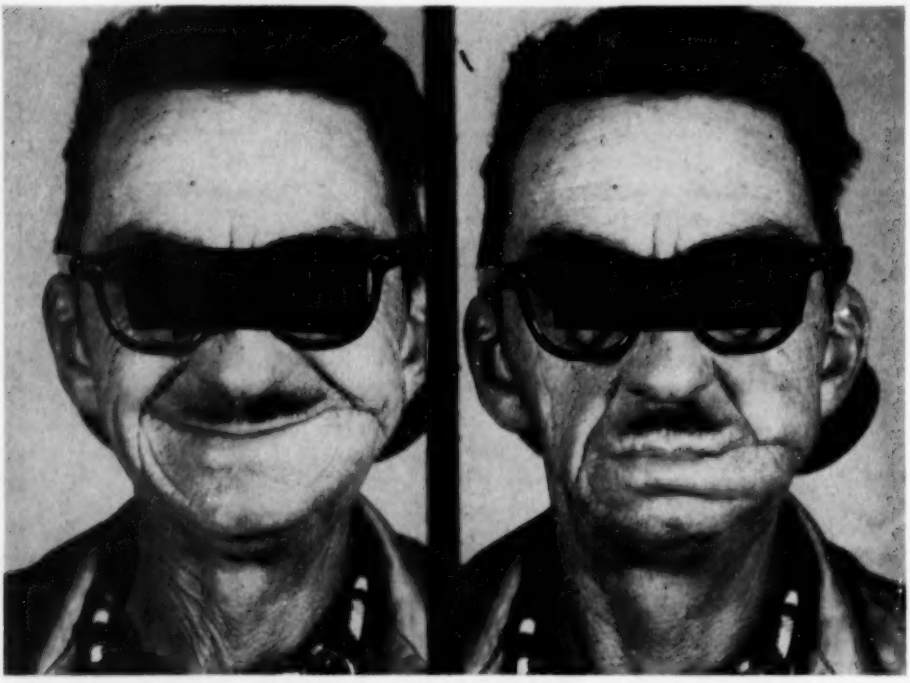

Fig. 6.—Postoperative results. The direction of the scar and the cicatrix which form prevent the familiar deformity caused by cutting the marginal mandibular branch.

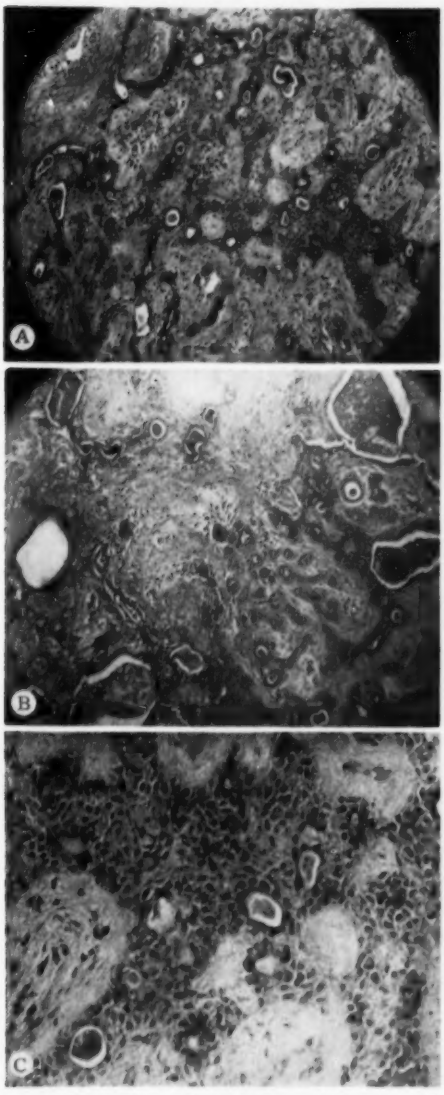

Fig. 8.—*A* and *B*, low-power photomicrographs of two different fields of the excised specimen. *C*, Higher power view of a section of the tumor.

closed. The postoperative course was uneventful. The tracheostomy tube was removed on the fourth postoperative day (Fig. 6).

The tumor weighed 160 gm. It was yellow in color, firm in texture, smooth in outline and measured 9 × 7 × 5 cm. (Fig. 7). There was no capsule with the exception of a fine, filmy adventitious covering. It was convex superiorly, conforming to the arch of the hard palate. The inferior surface was concave and was covered by a thick scarified mucous membrane. On cut section it showed a hard, slightly gritty, homogeneous surface interspersed with fine white fibrous bands. In between these septa was a softer yellow tissue which was moderately gelatinous. There were no cysts and no evidence of bony structure or hemorrhage. It presented a solid and heavy gross appearance which on histologic examination was quite variable. In one section (Fig. 8*A*), it resembled a basal cell tumor with strands and nests of cells, some of which were cuboidal. In another part, a loose central arrangement of the cells was seen, with the formation of small cystic spaces. The tumor had a dense hyaline, at times almost cartilaginous, stroma. A few areas showed a myxomatous stroma. In other fields the tumor appeared epidermoid (Fig. 8*B*), showing cells which had differentiated into stratified squamous types forming keratin and suggesting pearl formation. Higher-power views (Fig. 8*C*) revealed the formation of intermediate prickle cells and keratinized epithelium. The most characteristic cell was stellate, with a moderate amount of granular cytoplasm and a large vesicular, at times hyperchromatic, nucleus. No mitotic figures were seen.

It was the opinion of Drs. Bruno Gerstl and Richard Skahen, of the Department of Pathology, that the tumor was a typical adamantinoma of the acanthoma type.

SUMMARY

A patient with an extraosseous adamantinoma has been presented with a brief discussion of the tumor and of its rare nature. Because of its huge size an unusual surgical approach was used to remove it safely. The technique is described.

450 Sutter St.

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Facial Nerve Grafting in Treatment of Parotid Gland Tumors

New Technique

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Tumors of the parotid gland have been of particular interest to the clinician and the pathologist for the past 100 years. Their varied cellular arrangements have made their complete pathological classification a perplexing one. In the past, this situation was exaggerated by lack of an adequate correlation between the pathological classification and the appropriate therapy, thus causing the end-result analysis of the curative efforts directed against these tumors to be, in many instances, confusing. Recent efforts to clarify the microscopic classification of these tumors have been noteworthy. These classifications serve to emphasize the importance of the segregation of the various tumors of the parotid gland into their specific, microscopic categories, thus permitting the clinician to establish not only a more thorough and effective method of treatment, but a more accurate prognosis.

Tumors of the parotid gland are divided into benign and malignant groups. Benign tumors of the parotid gland consist of the following:

1. Benign mixed tumor
2. Lipoma
3. Fibroma
4. Hyperplasia of lymph nodes
5. Papillary lymphoid cyst adenoma
6. Serous cell adenoma
7. Acidophilic cell adenoma
8. Benign lymphoepithelial lesion
9. Basal cell adenoma
10. Oxyphilic cell adenoma

From the Head and Neck Department of the Pack Medical Group and the Surgical Service of St. Vincent's Hospital.

Malignant tumors of the parotid gland consist of the following types:

1. Malignant mixed tumors
2. Mucoepidermoid cancer (low-grade and high-grade types)
3. Adenocarcinoma (anaplastic type, mucous cell type, solid type, adenocystic basal cell type, acinous cell type, pseudoademantine type)
4. Squamous cell cancer
5. Unclassified type

Almost without exception, all of the benign tumors can be removed from the parotid gland without permanent injury to the facial nerve. The techniques employed are either the simple enucleation of a benign tumor, the excision of the benign tumor and a subtotal part of the parotid gland, or the excision of the benign tumor and the entire portion of the parotid gland. In the early limited low-grade type of mucoepidermoid cancer, the acinous cell adenocarcinoma, and other malignant tumors (less than 1 cm.) which are limited to the lateral portion of the parotid gland, total resection of the parotid may be carried out without permanent injury to the facial nerve. Postoperative irradiation is essential in this group.

In contrast to the aforementioned method of therapy, the other extensive malignant tumors of the parotid gland should be treated by wide, radical surgical excision of the parotid gland and facial nerve in continuity with a radical neck dissection. It is in this latter group that immediate muscle transposition and immediate autogenous nerve grafting add considerably to the total conception of the treatment of the surgical wound and the rehabilitation of the patient.

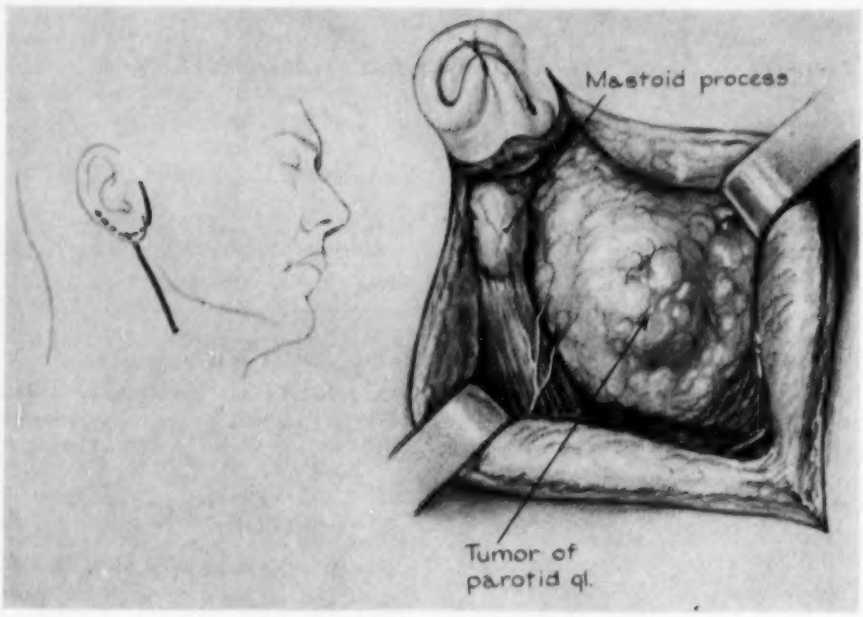
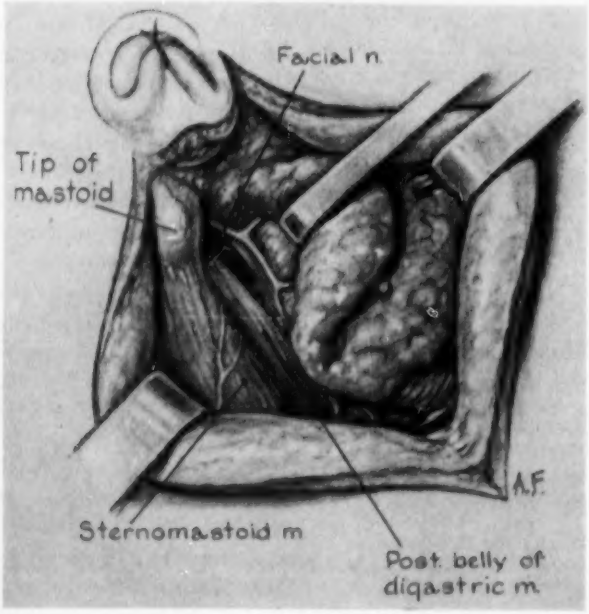


Fig. 1.—Parotid gland containing benign tumor. Incisions are outlined.

Fig. 2.—Exposure of facial nerve.



TOTAL PAROTIDECTOMY WITH PRESERVATION OF FACIAL NERVE

The skin incision for the exposure of the parotid gland consists of the classic Y incision about the ear, with the extension of the inferior arm down into the neck along the anterior border of the sternocleidomastoid muscle at its insertion just beneath the tip of the mastoid process. After the skin flaps and lobule of the ear have been appropriately retracted, the fascial spaces about the cartilages forming the external auditory meatus are entered by blunt dissection and followed to their depth. The anterior superior tendinous attachment of the sternocleidomastoid muscle to the tip of the mastoid is removed by sharp dissection. The anterior superior border of the posterior belly of the digastric muscle is then identified. The tip of the mastoid is then removed with appropriate bone instruments to facilitate exposure. The substance of the parotid gland with its capsule is retracted with a right angle blunt retractor at this site, exposing a small pad of fat and areolar tissue just anterior to the origin of the posterior belly of the digastric muscle and external to the styloid process. By gentle searching, the trunk of the nerve can be identified at this site without any difficulty as it is always contained in this pad of fatty and areolar tissue. Its absolute identity should be established by faradic stimulation. The nerve is then followed into the isthmus of the parotid gland, through which it passes in intimate association with the glandular structures. In the isthmus of the gland the nerve divides into the superior temporal and the inferior cervical trunks. Four main branches arise from these two main trunks going to the various regions of the face, namely, the temporal, the zygomatic, the buccal, and the mandibular branches. There are many combinations of nerve systems and outlets arising from these different branches. Over 80% of zygomatic and buccal branches anastomose with each other at some part along their course through the face. The mandibular branch anastomoses with the buccal in about 12% of the cases. These neurogenous ramifications begin in the substance

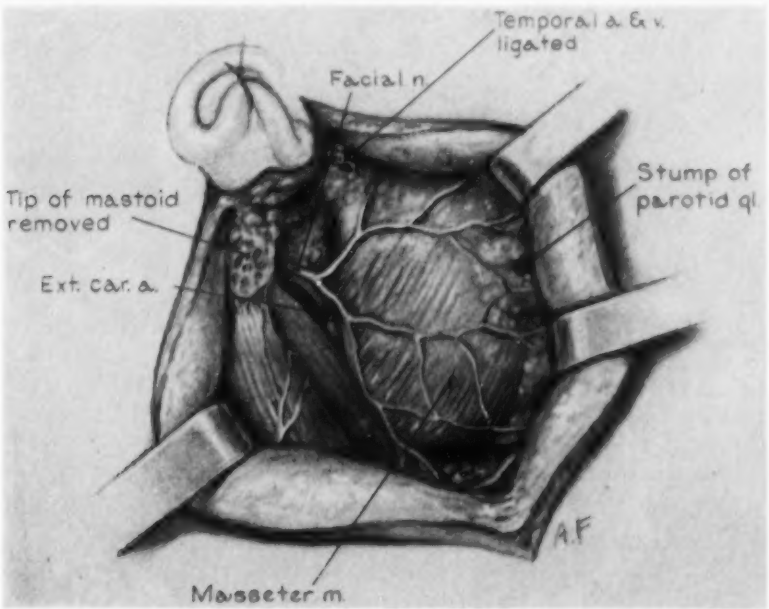


Fig. 3.—Total resection of parotid gland.

of the parotid gland, either in the isthmus or in the lateral lobe, and are intimately associated with it. Owing to this fact it is necessary to remove the parotid gland in two segments. Blunt dissection is carried along the main trunks of the facial nerve in their course through the parotid gland, separating the the inferior portion of the gland. Careful application of hemostats to control bleeding within the gland is necessary to prevent undue injury to the nerve. The faradic stimulator is helpful during this technique to identify specifically the branches of the facial nerve which are to be preserved. The wound

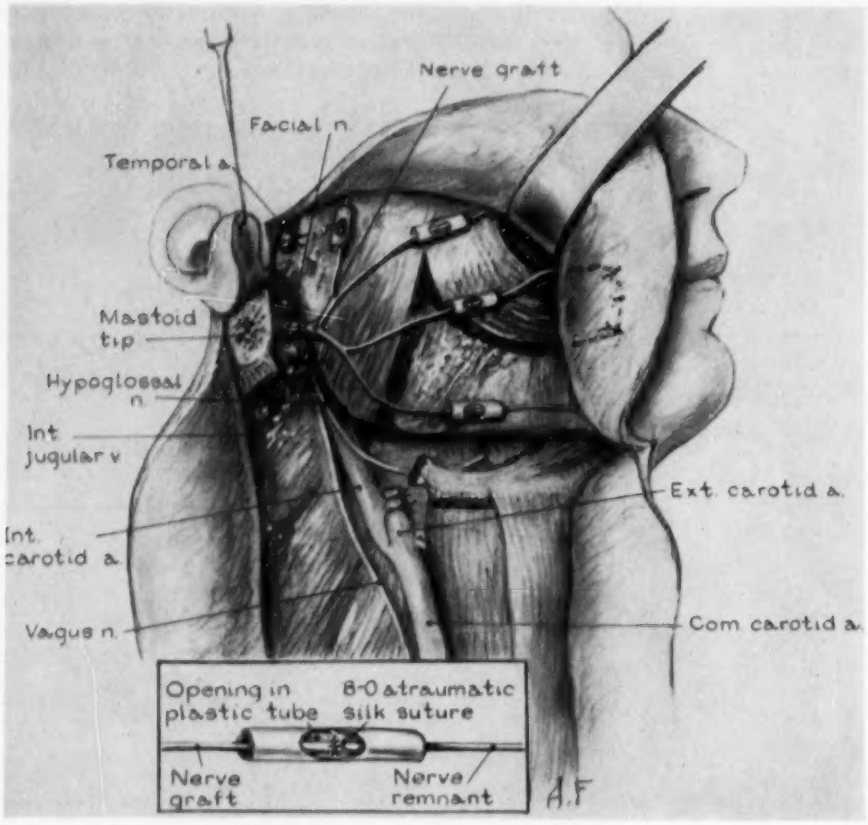


Fig. 4.—Technique of radical parotidectomy and neck dissection for cancer of the parotid, with immediate nerve grafting and muscle transplantation.

lateral lobe from the medial lobe. This necessitates a certain amount of maceration of the gland at the point of this separation. It also imposes trauma on the nerve itself. After the lateral lobe is totally removed, the nerve is retracted to one side, affording accessibility to the pterygoid extension of the parotid gland. This lobule usually comes out without any difficulty. The external carotid artery and associated vein must be securely tied at is closed with a small drain at the inferior pole, and a supportive dressing is applied.

There is occasionally a temporary paresis of the facial muscles after this procedure. The degrees of paresis is in direct proportion to the amount of trauma sustained by the nerve. This local trauma may be kept at a minimum by protecting the nerve with moist cotton during the dissection, by the judicious use of the suction tip, and by the careful applica-

tion of mosquito hemostats. Acute stretching of the nerve should be avoided. Small hooks should be used to retract the nerve as the dissection progresses. A voltage of 0.5 to 1.0 should be used for the faradic stimulation. In spite of the greatest precautions a paresis may develop and persist for from 1 to 12 months.

TOTAL PAROTIDECTOMY WITH FACIAL NERVE GRAFT

When it is anticipated preoperatively that a radical dissection of the facial nerve will be carried out in continuity with a block dissection of the neck and a total parotidectomy, reconstructive preparations are made to correct the facial paralysis resulting from this excisional technique. If there is no necessity to excise skin as a result of the attachment of the tumor to the skin or ulceration through the skin, the classic neck flaps are outlined and elevated. The superior arm of the posterior flap is carried up about the ear in a manner described in the previous paragraphs, to accomplish the formation of a Y about the ear. The flaps are then appropriately elevated and a complete radical neck dissection on the involved side carried out, including the internal and external jugular veins, the sternocleidomastoid, the omohyoid, and the posterior belly of the digastric and stylohyoid muscles, along with all associated fat, fascia, and areolar tissue. The tip of the mastoid is routinely excised in these cases, not only to facilitate the exposure of the main trunk of the facial nerve, but also to expose the parotid gland at this site. The external carotid artery is ligated just above the carotid bulb, and its superior segments are removed along with the specimen, which includes the subdigastric contents, suprahyoid space contents, and the entire parotid gland and associated soft tissues in this area. It may be necessary to remove the masseter muscle and ascending ramus of the mandible simultaneously.

After the entire specimen has been removed, a nerve graft previously procured from the contralateral side of the neck and composed of the great auricular and cutaneous collic filaments, with a trunk and four branches, is carefully adapted to the neural deficiency. The small branches of the facial nerve in the temporal, zygomatic, buccal, and mandibular areas have been previously identified by faradic stimulation and marked. The relative sizes of the great auricular trunk and facial nerve trunk are satisfactory for direct anastomosis. The relative sizes of their peripheral segments are also satisfactory for direct anastomosis.

Plastic tube cylinders are then carefully threaded over the distal segments of the free nerve graft. These plastic cylinders vary from 2 to 3 mm. in diameter, depending upon the size of the nerve graft. The nerve roots are then approximated with 8-0 Atraumatic silk. The minute nerve filaments and peripheral nerve filaments are then identified under high-powered binocular magnification and gently approximated with one through and through 8-0 Atraumatic silk suture. A plastic tube cylinder is then carefully slid down over this rather loose anastomosis so that about 1 cm. extends on each side of the anastomosis. Through a small window, which has previously been made in the plastic cylinder, the nerve filaments are teased into direct approximation with the point of a fine needle, to assist the 8-0 Atraumatic silk sutures. The graft should be tailored somewhat generously to prevent any traction on the suture lines. The approximation of the small distal nerve end fragments is checked again with high powered magnification. A drop of serum or blood is permitted to enter the plastic cylinder so that further stability and security will be offered the anastomosis by the congealment of this clot.

If the masseter muscle has not been resected during the excisional phase of the operation, its anterior border is freed from the angle of the mandible and approximately half of the anterior portion of the muscle transposed through a tunnel to the lateral commissure of the mouth. It is fixed to the orbicularis oris at this site with three small fine silk mattress sutures under moderate elevation tension. If the masseter muscle has

Fig. 5.—Radical neck and total parotid gland resection for squamous cancer of parotid gland. The great auricular nerve has been anastomosed to the facial nerve branches. The masseter muscle has been mobilized for transportation to the oral commissure.

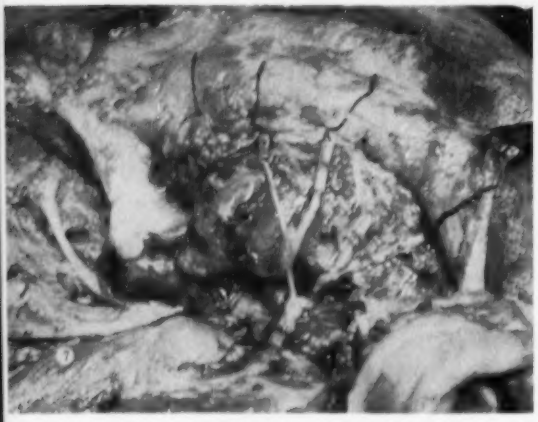
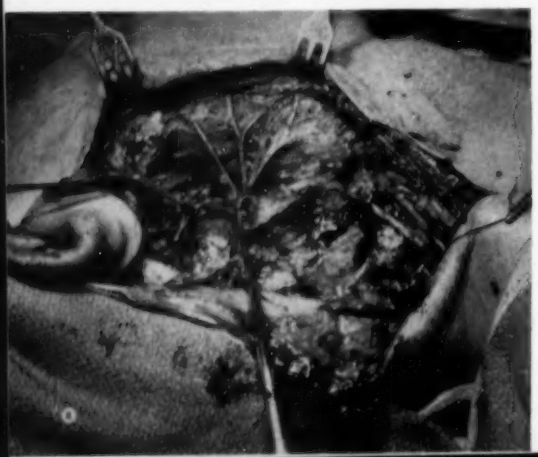


Fig. 7.—High-power view of facial nerve graft and plastic tubing.

been removed along with the ascending ramus of the mandible, one may transpose the amputated coronoid process of the mandible with its temporal tendinous attachment toward the commissure of the mouth and fix it in a manner similar to that described for

Fig. 8.—Total parotid gland resection and preservation of the facial nerve.



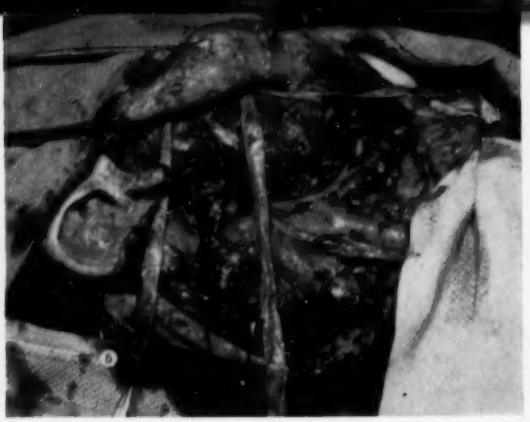


Fig. 6.—Autogenous fascia lata suspension of face.

the masseter muscle. The temporal muscle itself is not quite long enough without the assistance of the coronoid process to reach the commissure of the mouth. If these muscles are not available for transplantation, a fascia lata graft should be carried out, utilizing three strips of autogenous fascia lata: one for the lower lip, one for the commissure, and one for the upper lip. Elevation and tension are obtained by suturing each to the temporal muscle and fascia. Overcorrection is always desirable. A lateral tarsorrhaphy is then performed on the eyelid to prevent corneal ulceration or excessive epiphora. The wound is closed with adequate drainage at the inferior pole, and a supportive dressing is applied. After several weeks, stretching and relaxation of the tissues which have been used will permit the face to drop to a normal position.

When the skin over the tumor is ulcerated or involved and is excised with the specimen, this defect may be covered by rotating the neck flaps superiorly over the graft or by transposing a previously prepared chest flap.

Limited active movement in the area of the commissure is noticeable within approximately three weeks after transplantation of the masseter or temporal muscle. This is accomplished by having the patient tighten the muscles of mastication. The movement is minimal but assists in keeping the paralyzed side of the face alive and also acts as a tremendous boost to the patient's morale.

MATERIAL AND RESULTS

Facial nerve grafting was carried out seven times from 1951 through 1953 for the treat-

ment of malignant tumors of the parotid gland. All of these malignant tumors had been previously operated upon at least one occasion and had manifest recurrence. There was segmental preoperative facial paralysis. The great auricular nerve was used in all instances, and the length of the graft varied from 50 to 90 mm. Auxilliary fascia lata suspensions were carried out in one instance

Fig. 9.—Face with grafted right facial nerve.

and masseter muscle rotation was carried out in three instances along with the nerve grafting. Three patients obtained good results (from 65 to 90% return of function) within from 8 to 12 months. None of these patients had a graft longer than 60 mm. One patient obtained a poor result (30% return) in 10 months. One patient was a total failure except for a minimal amount of movement (3%) in the region of the risorius muscle after 18 months. This patient is of particular interest because she had excellent tone in the operated side of the face for the first six months postoperatively. The tone gradually disappeared, and the only function that returned was this minute movement in the region of the risorius muscle. Her graft was 80 mm. long. Re-exploration of the graft after an interval of 20 months revealed excessive scar tissue about the proximal anastomosis. The main trunks of the nerves were so invaded by scar that their specific continuity could not be demonstrated. Testing this mass with faradic current revealed good movement of the cheek, although preoperative testing revealed no movement. The facial nerve in the mastoid bone and the nerve graft appeared normal grossly. The scar was excised and a fresh anastomosis carried out in conjunction with a masseter muscle transposition. Two patients were complete failures, one with a 60 mm. and one with a 90 mm. graft. Re-exploration in these two revealed considerable scar tissue about the plastic tubes. The grafts were atrophic.

It is an interesting addendum to the above data to add an experience with two children, aged 5 and 7, who were operated upon during the same interval but not included in this series. These two children had extensive malignant (sarcoma) tumors growing in the ascending ramus of the mandible, parotid gland, and pterygoid areas. Wide resections

of the mastoid area, facial nerves, parotid glands, and ascending ramus of the mandible and pterygoid area were carried out in each instance. A section of approximately 50 mm. of facial nerve was removed in each instance. No effort was made to perform a nerve graft or carry out a suspension operation of the face at the time. Within 12 months there was approximately 90% spontaneous recovery of the function of the face. The scientific explanation of this unusual phenomenon is not apparent. Similar improvements after resection of the hypoglossal and spinal accessory nerves have also been noted in children. I have never seen this phenomenon (regeneration and reactivation) in adults. The prognosis for recovery after resuturing a severed facial nerve is much better than that for a free nerve graft.

CAUSES OF FAILURE

The primary cause for failure is the operative technical difficulty of attaining an accurate anastomosis in the smaller filaments of the facial nerve in the check. Although this new technique overcomes many of the obstructions to accurate anastomosis, it certainly is not perfect in all instances. Even after the graft has been anastomosed perfectly, scar tissue can invade anastomotic site and prevent regeneration. Interference with nourishment and delayed scar tissue contraction of the tissue bed may cause delayed atrophy of the graft. The plastic tube itself may cause ischemia of the graft. This is overcome by having its diameter at least two or three times that of the graft. The basic factors pertaining to the chemistry of neurogeneration in motor nerves are little understood at the present time. It is strongly advised that this technique be carried out on the peripheral nerves of rats 20 or 30 times before it is attempted on humans.

ANALYSIS OF IMPROVEMENT

Faradic testing was, of course, of no value in prognosticating the regeneration or atrophy of the nerve graft during the postoperative course. It required from 8 to 14 months, depending upon the length of the graft, for function to return. Some patients had a return of motor capacity in the operated side of the face and were not aware of it until specifically instructed how to use it. It was extremely difficult in all instances for the patient harmoniously and effortlessly to associate the movements of the face. This phase of recovery was much more acute than that encountered with direct suturing of a severed nerve. In order to overcome this dissociation it was necessary for the patient to apply supreme concentration and practice in front of a mirror for from two to four weeks. The return is never complete, varying from 3% to 90%. Hypertonia of the operated side of the face became apparent in several instances, even when muscular movement was awkward. In addition to this, the patients often complained of a sensation of tightness and occasionally a complete lack of control over the movements of the operated side of the face. Involuntary twitches, tics, and spasms on the operated side were not uncommon.

SUMMARY AND CONCLUSIONS

A new method of facial nerve grafting has been studied. It is applied to nerve filaments of very small diameter (0.5 mm.).

This technique consists of the use of a small plastic cylinder, magnification, and delicate suture material. The aim of the technique is to facilitate the approximations of the nerve ends and reduce the effect of scar tissue.

It has been applied with moderate success in humans with recurrent malignant tumors of the parotid gland requiring radical neck resection and total parotidectomy.

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Effect of Age on Mechanism of Death and Ability to Tolerate Acute Hypothermia in Dog

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Generalized hypothermia as an aid to cardiac surgery has received much recent attention.* Ventricular fibrillation has been encountered as a major handicap in hypothermia both prior to and during cardiac surgery. The propensity of the cold heart to undergo this functional degeneration is well known.†

This present work is the result of a laboratory trial of this technique preparatory to its contemplated use clinically. It was decided to test hypothermia alone to determine the mode of death in its most profound aspect.

METHODS

A total of 30 dogs, 15 adult and 15 juvenile (i. e., those with deciduous teeth) mongrel dogs of both sexes and of variable weights, 6 to 22 kg., were anesthetized with pentobarbital sodium, 60 mg/kg., with increments of 30 mg/5 kg., given as necessary to prevent shivering. Hair was removed from the entire body, excepting the legs, beyond the proximal joints, the head, and tail. Artificial respiration at 36/minute, with 100% O_2 at 10 to 15 cm. H_2O pressure, was administered via endotracheal tube from the outset of each experiment. Venous and arterial blood pressures were measured via femoral cannulae by Sanborn electromanometers and recorded on the Polyviso. Heparin sodium, 3 mg/kg. was administered intravenously to maintain patency of vascular cannulae. Simultaneously, a record was made of ECG Lead II. The extremity leads were attached to the animal by needle electrodes. The source of refrigeration was a machine and blanket similar to that used by Bigelow [3] (Fig. 1). A continuous record of subcutaneous, rectal, inflow refrigerant and outflow refrigerant temperature was maintained on Leeds-Northrup Micromax recorder via iron-constantan thermocouples enclosed in nylon. The subcutaneous thermocouple was enclosed in a 1.5-in. (3.8 cm.) section of 13-gauge hypodermic needle, and this was inserted full length beneath the skin of the back at a point where maximum contact with the cooling blanket was present. The rectal thermocouple was attached by cellulose tape to a laboratory thermometer and inserted 10 cm. Blood-gas measurements were estimated by the method of Van Slyke.

No surgery was performed other than the minor procedures incidental to cannulation of the femoral vessels. The only contact with the animals after the onset of cooling was during the administration of anesthetic increments. The average rate of cooling was 4.2 C per hour. Refrigerant fluid gained 1.6 C temperature on an average from extrance to exit of the blanket.

These animals were cooled progressively until death occurred (Fig. 2). The end-point was estimated by the ECG evidence of ventricular fibrillation or cardiac arrest.

Fig. 1.—Experimental hypothermia apparatus with an animal in place under refrigerated blanket. Recording equipment is at the right and along the side. Refrigeration unit is on the left.

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Supported by a grant from the National Institutes of Health, Project H-1110 (C2).

* References 3, 4, 5, 6, 7, and 19.

† References 3, 6, 16, 17, and 19.

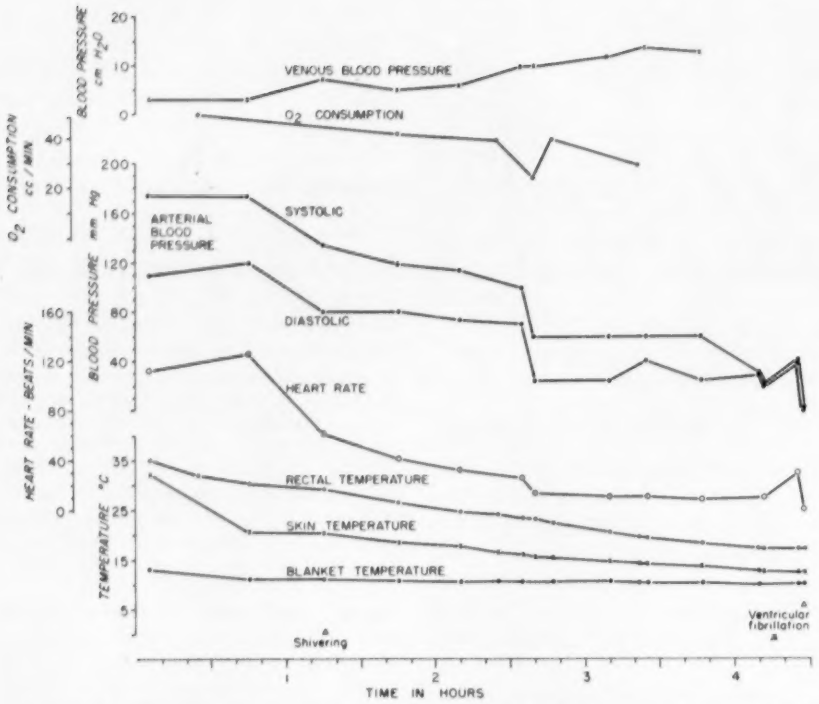

Fig. 2.—A graphic representation of typical values obtained in an experiment ending in ventricular fibrillation.

RESULTS

Group 1: Adult Dogs.—Venous Blood Pressure: Venous pressure increase in generalized hypothermia has been cited as a possible cause of ventricular fibrillation.[4] For this reason venous pressure was measured in 12 experiments. An increase was recorded in six cases, a decrease in six cases. The group showing a decreased venous blood pressure died at an average of 0.3 C lower than the group showing the increase (Table 1).

TABLE 1.—*Comparison of Average Lethal Temperatures Associated with Venous Pressure Change*

ADULT ANIMALS DYING OF VENTRICULAR FIBRILLATION WITH VENOUS PRESSURE CHANGE	
TOTAL	12
INCREASE	6
average low temperature	20.9°C
DECREASE	6
average low temperature	20.6°C

ECG: In 25% of the experiments a progressive degeneration in the cardiac conduction pattern was noted. This degeneration constituted an irregularity of rhythm wherein a sinus arrest or A-V block was present. It was observed that sinus patterns were interposed with nodal and up to four different ectopic patterns. There was no organized sequence in the occurrence of each. As the rectal temperature decreased, the incidence of sinus and nodal configurations diminished, leaving one dominant ectopic focus to maintain the very slow idioventricular rhythm until ventricular fibrillation supervened.

In four experiments records of the exact onset of ventricular fibrillation were obtained. In one case no predisposing irregularity was noted. In the others ventricular extrasystoles preceded fibrillation by several heart beats. In most cases the initial spiking

TABLE 2.—*Summary of Results in Experimental Acute Hypothermia in Adult Dogs*

GROUP I: ACUTE HYPOTHERMIA IN ADULT DOGS	
TOTAL	15
AVERAGE LOW TEMPERATURE (i.e. fibrillation temperature)	20.4°C
MODE OF DEATH	
ventricular fibrillation	15
cardiac arrest	0
SECONDARY PACEMAKER ACTIVITY	4
average low temperature	17.3°C
SPONTANEOUS VENTRICULAR FIBRILLATION	11
average low temperature	21.6°C

activity was observed to originate in the S-T segment of a recognizable configuration.

In all experiments conducted the ECG records show an alternation in polarity of the T-wave, which was slow in time and was independent of the initial polarity. It was of cyclic character, occurring several times in each experiment. This was considered to be important at first, but it seemed to correlate with no other findings. This observation also has been made by others.[18]

In most experiments an aberration in the S-T segment in the form of an additional wave occurred. This was usually of opposite sign to the T-wave, but not invariably. It appeared to be distinct from the QRS complex and of much slower time relationship.

There was a generalized lengthening in time of all components of the ECG, the P-R and QRS changing the least. The Q-T interval lengthened almost in proportion to the R-R interval. This lengthening represented an increase of 400 to 500%.

Respiration: As stated previously, the animals received artificial hyperventilation of 100% O_2 from the start of refrigeration. In a few cases blood-gas and pH determinations were made. These indicated a high O_2-low CO_2 content, and a tendency toward increased pH, but this was never above 0.2 pH.

Cause of Death: Of 15 adult mongrel dogs, the terminal event in each instance was ventricular fibrillation at an average rectal temperature of 20.4 C. Four of this number exhibited a progressive breakdown in the cardiac conduction pattern on the ECG. These four animals developed ventricular fibrillation at an average rectal temperature of 17.3 C (Table 2).

Group II: Fifteen Juvenile Mongrel Dogs (Those with Deciduous Teeth).—ECG: The electrocardiogram in the majority of the juvenile group showed preterminal conduction abnormalities which usually followed a sequence of sinus irregularity, nodal rhythm, and then slow idioventricular rhythm. In two experiments there were mixtures of nodal and idioventricular patterns. In one instance auricular flutter, which terminated in cardiac arrest of 10 minutes' duration, was followed by a nodal rhythm.

Alternation in polarity of the T-wave was uniformly present in this group, also.

Cause of Death: In the entire group of juvenile dogs the terminal event in profound hypothermia was cardiac arrest. The conditions prevailing were identical with the adult group, except that heparin was not administered and blood pressures were not measured. The average temperature at time of death was 12.6 C. All but three of this group exhibited some form of altered cardiac conduction prior to cardiac arrest. The three excluded had an average terminal rectal temperature of 14.2 C. The other 11 averaged 12.0 C (Table 3).

Other Observations: It was considered that possibly some protection from ventricular fibrillation would result from the use of procaine amide after the temperature reached

TABLE 3.—*Summary of Results in Acute Hypothermia in Juvenile Dogs*

GROUP II: ACUTE HYPOTHERMIA IN JUVENILE DOGS	
TOTAL	15
AVERAGE LOW TEMPERATURE	12.6°C
MODE OF DEATH	
ventricular fibrillation	0
cardiac arrest	15
SECONDARY PACEMAKER ACTIVITY	11
average low temperature	12.0°C
SPONTANEOUS CARDIAC ARREST	4
average low temperature	14.2°C

the critical temperature of 25 C. In the two cases (not included in this study) in which this drug was used, ventricular fibrillation resulted within two minutes after injection. While this drug is an excellent depressant during normothermic tachycardia, it seemed to hasten the onset of ventricular fibrillation during hypothermia. If differential depression of the conduction system versus the myocardium occurs in hypothermia, then possibly procaine amide potentiates this difference.

In a few cases arterenol (nor-epinepherine) was used to maintain blood pressure in the lower ranges of hypothermia in an effort to forestall ventricular fibrillation. Interestingly, in these experiments the cold animal responded to this drug by increased peripheral resistance and tachycardia, but after a short interval the rhythm became chaotic, and ventricullar fibrillation resulted.

During these experiments no constant ECG picture was observed which could be accepted as a warning of impending ventricular fibrillation. In those animals displaying secondary pacemaker activity, however, lethal temperature was being approached when the irregularity appeared. It was not possible to predict which animal would possess a secondary pacemaker.

The duration of these experiments until fatal termination occurred depended upon many factors. The average duration of the experiments varied in the juvenile animals from 128 to 420 minutes (average, 219 minutes). In the adult animals the duration varied from 105 to 325 minutes (average, 256 minutes). There appeared to be no correlation between the length of the hypothermia and the mode of death. Furthermore, the largest dogs did not necessarily have the slowest rate of cooling. As one might suspect, owing to the differences in body build of the animals used, the weights per se did not always give an accurate indication of either the age of the animal or of the rapidity with which cooling occurred. This is well exemplified by the overlap of weights in the two groups, the extremes in the juvenile animals being from 1.5 to 11.4 kg. and in the adults, 6.5 to 22 kg.

COMMENT

Various investigators have indicated different mechanisms which initiate fibrillation during hypothermia. It has been suggested that a relationship exists between increased venous pressure and fibrillation,[4] an increased titer of epinephrine produced by anoxic adrenals in inferior vena cava blood,[6] and hypokalemia.[19] As a corollary to these implications, it has been felt that phlebotomy, premedication with an isoquinoline derivative, WIN 2173, and the introduction of potassium and calcium into the coronary arteries have all been associated with either prevention of fibrillation or its conversion to a normal sinus rhythm. It is of interest that simultaneous rewarming has been an ancillary maneuver in most experiments. Furthermore, rewarming itself has been noted to produce a reversion to normal rhythm.

It has been shown that a normal animal will undergo ventricular fibrillation in response to electrical, chemical, mechanical, and thermic stimuli.‡ It is well known that the normothermic animal in fibrillation often can be resuscitated by removal of the stimulus. While certain similarities exist between normothermic and hypothermic animals and the development and control of fibrillation, other factors exist which deserve special comment.

During hypothermia, shivering is present unless it is controlled. Shivering is attended by a utilization of liver glycogen, which results in an increase of circulating potassium.[10] During hypothermia kidney function is severely impaired.[17] Normally the kidneys exercise a careful control over potassium in the blood. These circumstances can result in hyperkalemia. In the studies reviewed § wherever hypothermia was performed on unanesthetized animals, including the dog, ventricular fibrillation was mentioned only rarely as a cause of death. In these experiments it is assumed that shivering accompanied the heat

‡ References 15 and 20.

§ References 2, 8, 9, and 13.

loss and, therefore, it is assumed that an increase in potassium was present, possibly a fortuitous prophylaxis. In the use of hypothermia to facilitate cardiac surgery, most workers have controlled completely the shivering reflex. It is in this group that ventricular fibrillation occurs in the highest incidence. Provided the temperature is reduced sufficiently,[18] normal calcium levels in the presence of hypokalemia (of unknown cause) is possibly the chemical stimulus precipitating ventricular fibrillation in the hypothermic dog. It is, however, probably not the entire picture. The degree of calcium and potassium imbalance reported by Swan would, in the normothermic, healthy animal, be tolerated in most cases.

However, it is conceivable, that minor stimuli, either alone or in combination, which in the normothermic animal would be innocuous may become significant. During the normal cardiac cycle there is a short period of susceptibility to ventricular fibrillation at a threshold electrical stimulus. Before or after this period, a similar stimulus evokes only an extrasystole or no response. This period of increased susceptibility to ventricular fibrillation lies in the Q-T interval. During hypothermia, the Q-T interval is observed to lengthen 400 to 500%. Consequently, it is possible that a stimulus (chemical or metabolic) of constant intensity, but of subliminal volume, could trigger ventricular fibrillation.

In these experiments, the fact that some cases exhibited a multiplicity of pacemakers, correlated with the observation that these same animals are able to tolerate lower temperatures, suggests that the usual conductile mechanism is depressed sooner than the contractile mechanism. Deprivation of an organizing influence, in some cases, must allow the myocardium to exhibit a measure of autonomy, i. e., contraction of independent fibrils or ventricular fibrillation. These observations suggest that different responses to cooling of various tissues exist.

Furthermore, the difference in response of adult and immature animals as noted in this study has received support from additional observers. Adolph [1] in studying infant animals of several species under hypothemia was able to demonstrate a significant difference in lethal temperatures from adults of the same species and did not demonstrate the occurrence of ventricular fibrillation in his experiments. It has been shown by Fairfield [11] that infant white rats, 0 to 10 days of age, can be cooled to a BMR of O with concomitant cardiac arrest and revived, with no cardiac abnormality. Bailey and co-workers || have suggested that in the human the age of 5 years be considered the upper age limit of human subjects for hypothermia; he found a lower incidence of ventricular fibrillation in this group.

One aspect of the problem of hypothermia which has been disregarded appears to be of paramount importance, namely, the effect of progressive cooling on enzyme systems. Certain facts considered to be common knowledge by biochemists offer a possible explanation not only of the arrhythmias of hypothermia but of the differential behavior of adult versus immature animals.

There can be no doubt that the ultimate pattern of cellular function is a description of the metabolic pattern peculiar to particular cells. It follows that alteration in the function of cells is a reflection of temporary or prolonged alteration in cellular metabolism. Metabolic gradients are predicated upon enzyme mosaics whose inherent balance is determinant. Enzyme mosaics are so complex that few in vivo studies of them have ever been attempted. Individual enzymes and simple in vitro systems have been studied widely. It is a matter of common knowledge that enzyme activity is modified by temperature. It is likewise known that the thermoactivity characteristics for mutually interacting enzymes forming parts of the same system may not, and usually do not, coincide. If a system (of extraordinary simplicity) were devised so that enzymes, substrates, and products were balanced and the reaction pro-

|| Downing, D. F.: Personal communication to the authors.

ceeded in a uniform manner at a temperature of 37.5 C, that system would undoubtedly deteriorate in its balance if the temperature were raised or lowered. The effect of this temperature change would be a relative inactivation or stimulation of any or all of the members of the system. This, in turn, would result in modification in concentration of substrates and products, which would in time derange the system. In any event functional alterations would result if the changes were profound. It is suggested that this functional alteration in the adult hypothermic dog heart is ventricular fibrillation.

In the records of this present work there is evidence that the normal conductive pathway of the myocardium is depressed before the contractile elements. The descending order of pacemakers appears to support this contention. The same depression has been observed in adult and juvenile animals. The culmination of this depression, however, has shown a striking difference between the two groups. If the foregoing assumptions are correct, the reason why juvenile animals in profound hypothermia die of cardiac arrest and adult animals under the same circumstances die of ventricular fibrillation must be the result of a difference in metabolic activity of the myocardium of each age group. In support of this reasoning, it is interesting to note that in comparative studies of many individual enzymes found in corresponding tissue of the young and adults of the same species, definite differences in activity have been observed.[12] In all probability, these differences are the result of peculiarities in patterns of enzymes or differences in enzyme concentration.

Potassium is well known as an inhibitor or accelerator of enzyme reactions. Calcium is similarly active though not necessarily in the same reaction. It is probable that calcium and potassium have been effective in artificially balancing a degenerating system by acceleration or depression of some components. Whether or not this process is in fact a further imbalance is unimportant, since the time relations are short and, as normal temperature is restored, the levels of electrolyte concentration become less critical. It is suggested that a further study into the behavior of enzyme systems during progressive cooling may be a fruitful one, resulting in a more logical approach to the problems of cardiac arrhythmias during hypothermia.

At present it is our belief that hypothermia of itself may create serious problems. These difficulties must be dealt with properly or the risks imposed are too great for the short additional times gained for intracardiac operations.

CONCLUSIONS

A series of adult and juvenile dogs has been subjected to progressive hypothermia until death occurred.

The mechanism of death in adult dogs has been ventricular fibrillation.

In juvenile dogs death has occurred regularly due to cardiac arrest.

In addition to a different mechanism of death observed in adult versus juvenile dogs, it has been noted that fatal cardiac alterations in rhythm occur at significantly lower temperatures in immature animals.

Some evidence presented suggests that secondary pacemaker activity tends to delay the onset of fibrillation or arrest.

The effect of progressive cooling on enzyme systems has been offered as a possible explanation of the cardiac arrhythmias and their different behavior in adult and immature animals.

C. A. Wiederheilm, Chief Laboratory Assistant, Department of Medicine, and Harold J. Barnett, Chief Laboratory Assistant, the Department of Surgery, gave technical assistance. Dr. Frank M. Huennekens Jr., Assistant Professor of Biochemistry, University of Washington School of Medicine, gave advice on the preparation of this paper.

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Acute Gall-Bladder Disease and the Common Duct

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The two common complications of chronic cholecystitis and cholelithiasis are acute cholecystitis and choledocholithiasis. These complications tend to develop late in the course of gall-bladder disease, occurring with much greater frequency in patients who have harbored gallstones for many years. Recognizing this tendency, Glenn [1] suggested routine exploration of the common duct in all patients over 60 years of age with gall-bladder disease.

The fact that acute cholecystitis, as well as common-duct stones, occurs more frequently in older patients suffering from long-standing gall-bladder disease suggests that these conditions might frequently be associated. Actually their association has rarely been stressed. It is usually assumed that the incidence of choledocholithiasis in acute cholecystitis is low.

Among the authors reporting a low incidence is Cole,[2] who stated that only 4 to 5% of patients with acute cholecystitis have associated common-duct stones. Glenn [3] found choledocholithiasis 40 times (6.5%) in 613 cholecystectomies for acute cholecystitis. Lester [4] recovered common-duct stones in 5% of patients with acute cholecystitis. From these reports one might justifiably assume that the problem is infrequent enough to reduce its significance to a minimum.

However, a few reliable reports have shown a much higher incidence of choledocholithiasis in acute cholecystitis. In a series of 134 patients with acute cholecystitis reported by Dunphy and Ross,[5] common-duct exploration was carried out in 42% (56 patients), and choledocholithiasis was found in 21% (28 patients). Buxton, Ray, and Coller [6] performed choledochostomy in 31% of their patients and recovered stones in approximately 14% of the total. Colcock [7] reported that common-duct stones occurred in acute cholecystitis as frequently as in chronic cholecystitis, an incidence of 16.8%. On the basis of these reports it would appear that common-duct stones are as significant in acute cholecystitis as in chronic gall-bladder disease.

Such a wide discrepancy in results is difficult to explain. One must either assume that there is great variation in the severity of disease in different series or conclude that wider and stricter indications for common-duct exploration are followed in some centers by resultant recovery of a higher percentage of common duct stones.

In an effort to throw light on this problem the records were reviewed of all patients operated on at the Portland Clinic for stone disease of the biliary tract during a 10-year period (January, 1942, through December, 1951). Cholecystectomy was performed 780 times for acute and chronic cholecystitis (Table 1). Primary choledochostomy was performed at the time of cholecystectomy in 199 patients (25.5%). Common-duct stones were recovered in 97 instances (12.4%).

A total of 105 patients with acute cholecystitis (Table 2) were operated on, cholecystectomy being performed in 98 patients and cholecystostomy in 8 (1 patient returned for cholecystectomy after preliminary chol-

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TABLE 1.—*Choledochostomy in Seven Hundred Eighty Cholecystectomies* *

	No.	Per Cent: 780 Patients	Per Cent: 199 Patients
Choledochostomy.....	199	25.51	.....
Choledocholithotomy.	97	12.44	48.74

* Ten years ending Jan. 1, 1952.

ecystostomy). Eighty-seven per cent of the patients were over 40, and 65% were over 50 years of age. The common bile duct was explored (Table 3) at the time of 27 cholecystectomies (27.5%), stones being recovered in 16 instances (16.3%). This, then, was a higher incidence of common-duct stones associated with acute cholecystitis than in the entire series of cholecystectomies. The incidence is the same as that for all cholecystectomies performed during the last three and one-half years of the study (Table 4), a period during which rigid indications for choledochostomy were followed. These findings corroborate the previously cited evidence from the Peter Bent Brigham Hospital,[5] the University of Michigan[6] and the Lahey Clinic,[7] namely, that in the definitive treatment of acute cholecystitis common-duct stones are as great a problem as in elective cholecystectomy.

The ideal method of treatment of patients with acute cholecystitis is still debated. In general, there are three distinct opinions: (1) that this condition should be considered a surgical emergency in every patient; (2) that all patients should be treated conservatively, operation being postponed either until the acute process subsides or until it is apparent that it is progressing and that perforation is imminent; (3) that immediate operation be performed only if the patient

TABLE 2.—*One Hundred Six Operations for Acute Cholecystitis on One Hundred Five Patients* *

Operation	No. Done
Cholecystectomy alone.....	71
Cholecystectomy and choledochostomy.....	27
Cholecystostomy	8*

* One patient returned for cholecystectomy.

TABLE 3.—*Primary Choledochostomy in Ninety-Eight Cholecystectomies for Acute Cholecystitis*

	No.	Per Cent: 98 Patients	Per Cent: 27 Patients
Choledochostomy.....	27	27.5	....
Choledocholithotomy....	16	16.3	59.3

is seen early in the attack, but that operation be postponed and conservative treatment carried out for the patient seen late (after 72 hours) in the acute attack.

The latter course has been followed in the present series (Table 5). Thirty-four patients were operated on within 72 hours of the onset of the acute attack. Definitive surgery was carried out in all but one. In this patient cholecystostomy was elected because of his age (84 years) and frail condition. Seventy-one patients were seen late in the course of the acute process (after 72 hours). Cholecystostomy was necessary in seven patients because in each the acute process failed to subside. One patient, an 80-year-old man, died of pneumonia on the 11th day after cholecystostomy; this is the only death in the series of 105 patients with acute cholecystitis. Only one of the remaining six returned for subsequent cholecystectomy. Operation was performed after subsidence of the acute attack in 64 patients. Thus definitive operation at an elective interval was done 65 times.

It is of interest to note the incidence of choledochostomy and choledocholithiasis in these two groups of patients. Common-duct exploration was performed in only 15% of the patients operated on within 72 hours of the onset of the acute attack, and stones were recovered in only 6%, whereas in the patients

TABLE 4.—*Choledochostomy in Two Hundred One Cholecystectomies* *

	No.	Per Cent: 201 Patients	Per Cent: 60 Patients
Choledochostomy.....	60	29.85	....
Choledocholithotomy...	33	16.42	55.0

* Three and one-half years ending Jan. 1, 1952, General Surgery Department.

operated on after symptoms had subsided, choledochostomy was indicated in 34% and stones were recovered in 21.5%. Although the series is small, these data suggest that in the presence of acute disease certain indications for common duct exploration were overlooked or disregarded. Baker and Koutsky [8] pointed out that of all indications for common duct exploration at the time of cholecystectomy, dilatation of the choledochus is by far the most important.

To explain the wide discrepancy between the number of choledochostomies performed by the same surgeons in these two groups of patients, one must infer that attempts to expose and explore the duct in the presence of edema and cellulitis of the hepatoduodenal ligament were often considered too hazardous, rigid indications being compromised for the sake of safety. After the acute process subsided, choledochostomy could be carried out with comparative safety, and, consequently, the incidence of common duct exploration rose sharply.

The criteria for exploration of the common duct in these patients were reviewed. Palpable stones in the duct were noted only four times. Jaundice occurred in 14 patients, 10 of whom had choledocholithiasis. Jaundice or palpable stones, or both were present in only 12 of the 16 patients in whom stones were recovered. Dilatation of the common duct was recorded 21 times. It was noted in 14 of the 16 patients who had choledocholithiasis. In the operative reports of the other two patients, the size of the common duct was not mentioned. All of the patients in whom common-duct stones were found had dilatation of the common duct or jaundice, or both. These data reemphasize the necessity of exposing the common duct to determine its size in order to avoid overlooking stones. That this applies to patients with acute as well as to those with chronic cholecystitis is obvious.

COMMENT

Review of the cases in this series corroborates the reports of Dunphy and Ross,[5] Buxton, Ray, and Coller,[6] and Colcock [7] that common-duct stones are as frequent in acute cholecystitis as in chronic gall-bladder disease. Dilatation of the common duct is unquestionably the most reliable sign of common-duct stones. Therefore the duct must be exposed in every definitive operation on the biliary tract. Failure to follow this rule will certainly result in overlooked stones.

It is significant that the same group of surgeons failed to apply this rule as rigidly when operating on patients with early acute disease as they did when approaching patients after subsidence of the acute process. The only possible inference to be drawn from this fact is that exposure of the duct in the presence of edema and inflammation was often too hazardous. This hazard is certainly enhanced when operation is elected from 3 to 12 days after the onset of the acute attack, since the technical difficulties are notoriously greater during this period.

Operative accidents, including injuries to the extrahepatic biliary-duct system as well as to the hepatic artery or its branches, are much too frequent. To suggest added dissection for common-duct exposure as a routine at this stage of acute cholecystitis is to invite many more injuries to these structures. Cholecystectomy may be impossible or too dangerous at this time. On the other hand, it has been carried out with reasonable

TABLE 5.—*Acute Cholecystitis* *

		Chole-cyst-ostomy	Chole-cyst-ectomy	Choledoch-ostomy		Stones Removed	
	No.			No.	Per Cent	No. Patients	Per Cent
Operation within 72 hours of onset.....	34	1	33	5	15.0	2	6.0
Operation after subsidence of attack....	71	7*	65	22	33.8	14	21.5

* One patient returned for cholecystectomy.

safety, the dissection commonly being started at the fundus of the gall-bladder. Identification of the cystic duct and artery can then be made with the gall-bladder free from its other attachments. Such maneuvers, however, do not reduce the dangers of exposure of the duct system in the face of inflammatory adhesions, edema, and cellulitis. In such circumstances, overlooking stones in one patient out of five or six may be a small price to pay for added safety. Certainly, it is better than risking serious injury to vital structures. Apparently this train of circumstances has not been unusual not only in the series here presented but in others as well. It would seem much more reasonable to decide preoperatively to do a cholecystostomy and postpone definitive operation if exposure of the common duct is not feasible without risk.

Realization of the high incidence of choledocholithiasis associated with acute cholecystitis suggests that the surgical approach to this disease deserves reevaluation. In the early hours of the acute attack cholecystectomy and choledochostomy are usually safe. This period may extend up to 48 hours but probably seldom goes beyond that interval. It seems reasonable, therefore, to continue the practice of early operation in these patients, with the reservation that efforts at definitive operation will be quickly abandoned if exposure of the common duct and choledochostomy appear hazardous. Cholecystostomy should be readily accepted without apology under these circumstances.

If patients are first seen more than 48 hours after the onset of the acute attack, conservative treatment is recommended, provided, of course, that the diagnosis is definite. The acute process will subside in a high percentage of patients, permitting definitive treatment after four to six weeks.

Continuing or increasing pain, exacerbation of pain after a period of relief, increasing tenderness or rigidity, persistent or increasing fever, rigor, increase in size of abdominal mass and rising leucocytosis are signs that the acute process is not subsiding but progressing. One must then assume that perforation is impending or has already occurred. Operation should be undertaken immediately.

Cholecystectomy and choledochostomy are obviously out of the question under such circumstances. Cholecystostomy, performed through a short transverse incision over the mass, under intercostal block and local infiltration, is simple and readily tolerated by these sick patients. In most instances cholecystectomy may be carried out, and is recommended, after a six-to eight-week interval. Cholangiography through the cholecystostomy tube or sinus often yields valuable information regarding the presence of common-duct stones, provided that the obstructing stone has been removed from the cystic duct at the time of cholecystostomy. A persistent biliary fistula also indicates common duct obstruction.

In advocating conservative observation and delayed operation in acute cholecystitis, Buxton, Ray, and Coller [6] listed a number of indications for immediate operation, namely, diabetes mellitus, severe cardiac or renal disease, and pregnancy. They further suggested that recurrent acute cholecystitis should be treated by early operation because in this situation rupture of the gall-bladder may occur early with few warning indications. Certainly, patients with these concomitant conditions do not tolerate continuing infection. Immediate operation after a brief preparatory period for correction of diabetic acidosis, repair of fluid and electrolyte losses, or rapid digitalization is indicated. In many such instances, cholecystostomy will be advisable even in the early hours of the attack. It will be nicely tolerated if done carefully without wide abdominal exploration.

Jaundice is, of course, never an emergency. However, unremitting jaundice requires operation earlier than the ideal period for subsidence of acute cholecystitis but certainly never in the hazardous period from the 3rd to the 12th day. Provided the obstruction at the cystic duct is removed, cholecystostomy will permit escape of bile from an obstructed common duct and allow cholemia to subside.

Thus choledochostomy is not imperative in obstructive jaundice if contraindications to its safe accomplishment are present. However, delayed operation in jaundiced patients in the present series permitted definitive correction of common-duct obstruction in every instance.

SUMMARY AND CONCLUSIONS

Common-duct stones are as frequent in acute cholecystitis as in chronic gall-bladder disease. They occur in approximately one out of five or six patients with cholecystitis, acute or chronic. Dilatation of the common duct is the best indication of their presence. Therefore, exposure of the duct is imperative in every patient undergoing cholecystectomy if choledocholithiasis is not to be overlooked.

To expose and explore the choledochus in the face of edema, vascular adhesions, and indurative cellulitis in the region of the hepatoduodenal ligament resulting from acute cholecystitis is to invite an increase in operative accidents to the duct or arterial system. The danger is greatest when operation is undertaken from the 3rd to the 12th day of the acute attack. Should cholecystectomy be elected in this interval many common-duct stones will be overlooked, since discretion prevents even the boldest surgeon from routine common-duct inspection under such circumstances.

Definitive operation, including choledochostomy when indicated, is usually possible, however, during the first 48 hours of the attack, before such pathologic changes in surrounding structures have developed. After this period operation should be postponed if possible until the acute process has subsided, preferably for four to six weeks. If the acute disease progresses, cholecystostomy should be willingly accepted as a temporary expedient.

It is believed that fewer surgical accidents and the recovery of more common duct stones will eventuate from the program outlined.

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Technique of Tricuspid and Mitral Commissurotomy

One-Stage Procedure

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Tricuspid stenosis has been demonstrated to be present in 10% to 15%* of patients with valvular rheumatic heart disease. It is invariably associated with disease of other valves,[3] and its occurrence as a result of etiological factors other than rheumatic fever is rare.† The effect on cardiovascular function, therefore, of the tricuspid stenosis usually is only a part of the total disturbance of multivalvular involvement and is present only in the late stages of rheumatic heart disease.

Nonetheless, in spite of the operative risk imposed by the severity of the cardiac involvement, stenosis of the tricuspid valve is amenable to surgical intervention. So far as we know,‡ only three cases of surgical correction have been reported. We believe, however, that tricuspid and mitral commissurotomy, as a one-stage procedure, is indicated in certain patients.

Experience with patients having both mitral and tricuspid stenosis of sufficient severity to warrant surgical intervention relating to both valves has been minimal. Thus no clear-cut criteria, as yet, have been evolved for the selection of candidates for this procedure. The initial evaluation, including a thoughtful history, careful physical examination, and fluoroscopy will permit a diagnosis of tricuspid valve disease, but these tests are usually not sufficiently precise to establish the diagnosis of "tight" tricuspid stenosis. In making this decision, we feel that information obtained by right heart catheterization offers significant aid. It is at present considered that an increase in the early diastolic pressure gradient between the right atrium and right ventricle is the most dependable hemodynamic characteristic of surgical tricuspid stenosis.

Another aspect of the problem presents itself in the decision as to the presence of "tight" mitral stenosis when significant tricuspid stenosis is present. Since many of the characteristic features of "tight" mitral disease, such as symptoms of pulmonary congestion, the physical findings of pulmonary hypertension, and the fluoroscopic evidence of pulmonary vascular engorgement are dependent upon the presence of unimpeded output of blood from the right ventricle into the pulmonary vascular bed obstructed by the mitral valve, the presence of significant tricuspid stenosis, by greatly decreasing the output of blood from the right ventricle, significantly alters many of these characteristic findings of "tight" mitral stenosis. Its pressure may be masked and operative decision thus rendered difficult.[9]

Thus it must be realized that, at the present state of our knowledge, there are problems relating to the diagnosis of the association of "tight" mitral and tricuspid stenosis and that no clear-cut criteria have as yet been established.

We have observed five patients in whom this diagnosis was made and are reporting

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* References 1 and 2.

† References 4 and 5.

‡ References 6, 7, and 8.

here the three cases in which bilateral valvulotomy was carried out. In two of these patients, both the mitral and the tricuspid lesions were severe and were corrected by finger-fracture commissurotomy. In the third patient, since the tricuspid stenosis was of only moderate degree the tricuspid commissurotomy probably added little to the benefit obtained by correction of the mitral lesion.

CASE 1.—F. Z., a 38-year-old white woman, was admitted to the hospital on May 19, 1953. She had recurrent bouts of tonsillitis and ear infections during childhood, and at the age of 12 years had the onset of fatigue and exertional dyspnea. The patient was able to do housework and to bear three children. At the age of 36, the severity of weakness and dyspnea increased, and the following year paroxysmal nocturnal dyspnea and orthopnea occurred, as well as swelling of the abdomen. Moderate improvement followed digitalization. At the time of admission, the patient's exercise tolerance was limited to one block and only light household duties.

Physical examination revealed a thin, chronically ill woman with a violaceous hue over the malar eminences. A presystolic pulsation was noted in the deep cervical veins in the erect position. The heart was enlarged to both the left and right sides, and murmurs present were consistent with the diagnosis of mitral and tricuspid stenosis plus some tricuspid regurgitation. The liver was palpable 6 cm. below the right costal margin, and pitting edema of the ankles was present.

Fluoroscopy revealed considerable enlargement of the right and left atria and moderate enlargement of the right ventricle. Cardiac catheterization showed a small pressure gradient in early diastole from the right auricle to the right ventricle. Following exercise, there was an accentuation of this condition. The cardiac index was reduced, and there was an increase in the arteriovenous oxygen difference.

A thoracotomy was performed, with the use of the usual anterolateral intercostal incision. The mitral valve was markedly stenotic and was opened digitally. No regurgitant jet was obvious after manipulation. The incision was then extended across the sternum and attention was directed to the right auricle. Examination of the tricuspid valve revealed a marked regurgitation, with only moderate stenosis. The stenosis was corrected digitally without increasing the regurgitation. Attempt at correction of the regurgitation was not successful, and it was thought wise to conclude the procedure at this time.

Six months later the patient was performing all household duties and her exercise tolerance had markedly increased. The pulsation and distention of neck veins was absent. Repeat cardiac catheterization had not been done at the time this paper was written.

CASE 2.—M. C., a 43-year-old white woman, entered CGH in October, 1953. At the age of 14 years, she had a bout of fever and migrating polyarthritis. A second episode occurred at the age of 18 years. However, the patient carried eight pregnancies to term, and had two spontaneous abortions between the ages of 20 and 32 years. During the last pregnancy, the patient noted fatigue, exertional dyspnea, and episodes of paroxysmal nocturnal dyspnea. At 33 years of age, there was a recurrence of fever and migrating polyarthritis for a period of five months. After this, substernal and precordial pain on exertion and palpation were noted by the patient. When she was 42, there was the onset of swelling of the abdomen, pain in the upper abdomen, and a sense of fullness in the neck. The patient's exercise tolerance was one block.

Physical examination revealed a chronically ill woman who had a violaceous hue to the face and pitting edema of the ankles. The retinal veins were dilated, and the deep cervical veins were distended; a systolic pulse wave was present. The heart was enlarged to the left and right, and murmurs were present suggesting both mitral and tricuspid stenosis. The liver was tender and enlarged 8 cm. downward.

The electrocardiogram revealed atrial fibrillation and digitalis effect but no evidence of right ventricular hypertrophy. Fluoroscopy showed an enlarged right and left auricle, right ventricle, and superior vena cava. The lung fields were clear. Cardiac catheterization revealed a pressure gradient between the right atrium and the right ventricle in early diastole of 9 mm. Hg. Following exercise, this increased to 17 mm. Hg. The arteriovenous oxygen difference was 105.1 cc/L., and the cardiac index was 2.2 L/min/m^2, with little rise following exercise (2.7 L/min/m^2).

Thoracotomy was carried out through the usual incision in the left anterolateral aspect of the fourth intercostal space. Palpation of various chambers revealed a thrill over the right ventricle in diastole. The left auricle was not so much enlarged as the right. The pulmonary artery and vein were not as enlarged as in a patient with mitral stenosis only. After the pericardium was opened, a noncrushing clamp was applied to the left auricle and suitable stay sutures were inserted; the tip was excised, and exploration of the mitral valve was carried out. This revealed a moderately firm mitral valve, with a slight regurgitant jet present. Commissurotomy was carried out, correcting the stenosis and not increasing the regurgitation. The finger was withdrawn as the clamp was applied, and a layer of No. 3-0 black nonabsorbable (silk) interrupted sutures used to close the auricle. The incision was then extended across the sternum into the fourth interspace in the right, approximately two-thirds

of the way. Good exposure was thus given to the enlarged heart. After the pericardium was opened farther, a finger was now inserted into the right auricle after it had been opened as described for the left auricle. One could feel the commissures to be firmly fused and the free edges of the valves thickened. However, there was a 2+ regurgitant jet present prior to manipulation of the valve. A posterolateral commissurotomy was carried out. After this, the valve admitted two fingers easily, and the amount of regurgitation was not increased. The right auricular incision was then closed. The patient was in good condition when she returned to the recovery room.

Postoperatively, the patient was placed in an oxygen tent with a humidifier added to aid in expelling secretions of the respiratory tree. Antibiotics (penicillin and streptomycin) were given daily. The chest tubes were removed on the second day postoperatively. The pain of this type of an incision is not noticeably more than that of the usual standard thoracotomy incision and was controlled with small doses of meperidine (Demerol). The patient was slowly ambulated and was discharged home in three weeks. Ankle edema, which appeared shortly after surgery, remained for three weeks and then cleared.

Cardiac catheterization one month postoperatively revealed the pressure gradient between the right auricle and the right ventricle to have fallen to 3 mm. of Hg during early diastole.

Fig. 1 (Case 3).—Photograph of skin incision used for the bilateral thoracotomy (transternal) approach.

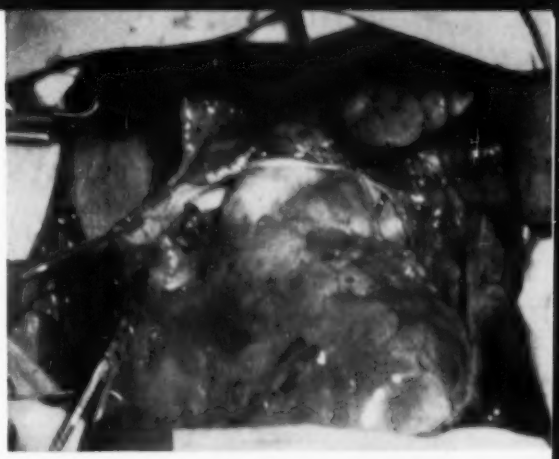

Fig. 2.—The exposure obtained with the bilateral thoracotomy incision crossing sternum. Pericardium is opened widely, allowing access to both left and right auricle. The sutured base of the excised right auricular appendage is seen.

Since surgery, the patient has gradually increased her activities. Two months after operation, the patient was doing all of her household work. Upon examination, the heart size remained the same, and the intensity of the systolic and diastolic murmurs in the left fourth and fifth interspaces had decreased. The liver was found to be 2 cm. below the right costal margin, and ankle edema was absent.

Case 3.—H. K., a 21-year-old man, was admitted to the hospital on March 31, 1954. At age 14, this patient had an episode of fever and joint swelling which lasted only a short time. Since then, he was well until two years ago, when he noted mild fatigability and shortness of breath when he engaged in sports. This condition was slowly progressive. His exercise tolerance walking on level streets was one mile. However, climbing up one flight of stairs caused shortness of breath.

Physical examination revealed the patient to be a well-developed well-nourished man. A rapid venous pulsation was visible in the neck. The heart was enlarged to the right and to the left. Murmurs present were consistent with the clinical diagnosis of mitral and tricuspid stenosis. The liver was palpable 5 cm. below the right costal margin. No peripheral edema was present.

Fluoroscopy confirmed the right and left enlargement of the heart. The left auricle showed slight enlargement, and the right ventricle was markedly enlarged. The lung fields were clear. Cardiac catheterization revealed the pressure gradient not to be markedly elevated at rest. However, on exercise the right auricular pressure rose markedly (20 mm. of Hg), showing the typical contours of tricuspid stenosis. The arteriovenous oxygen difference was elevated (11.5 vol.%), and the cardiac index was low (1.6 L./min/m^2).

As described in the previous case, the thoracotomy incision for mitral commissurotomy was carried out first, and a tight mitral stenosis was found. This was corrected so that a finger-and-one-half opening

was established without any regurgitation occurring. The incision was then extended across the sternum (Fig. 1) into the right fourth intercostal space, obtaining good exposure of the heart (Fig. 2). The right auricle was entered. The tricuspid valve was tightly stenosed—equal in degree to the stenosis of the mitral valve. Manipulation of the lateral and the posteromedial commissures could not be done digitally and was accomplished by means of the Harken knife. A two-finger opening was thus established; the amount of regurgitation was slight.

The patient's early postoperative course was uneventful. He was discharged home four weeks after surgery. He has returned to his preoperative level of exercise tolerance. It is as yet too early to evaluate properly this patient's long-term result.

COMMENT

The usual clinical findings in these three patients gave the impression of a stenotic tricuspid valve. However, whether this was "tight" or not could not be determined by physical examination alone. Other findings suggesting the need for surgical correction of tricuspid stenosis were the presence of a low cardiac index, with little rise following exercise; a considerable increase in the peripheral oxygen extraction, and, particularly, an increase in the early diastolic gradient between the right auricle and right ventricle.

The presence of a significant degree of mitral insufficiency eliminates the possibility of a beneficial result from surgery in many cases, whereas some tricuspid insufficiency does not necessarily do so. Accordingly, the mitral valve must be attacked surgically first. If one obtains a good technical repair by manipulation of the mitral valve, the thoracotomy incision may then be extended across the sternum into the right side and exploration of the tricuspid valve carried out. We have used this incision previously in other types of cardiac surgery and find it gives excellent exposure.[10] It has provided a stable thoracic cage postoperatively and has caused no more distress than the standard thoracotomy incisions.

Postoperatively, these three patients, as noted, have had an increased morbidity as compared to the patient undergoing only a mitral commissurotomy. An increased fluid retention in the immediate two or three weeks postoperatively has been a perplexing problem; however, this eventually cleared. Cardiac irregularities were more frequent and more difficult to convert. It is realized that patients with multivalvular lesions have a severer impairment of cardiac function and therefore present themselves with an increased surgical risk. However, since their eventual outlook without surgery is so poor, a combined attack on the two valves appears to be warranted.

SUMMARY

Three cases of bilateral atrioventricular valvulotomy are presented, and the methods of diagnosis and technique of surgery are described.

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Basal Cell Carcinoma of Rectum

Report of a Case

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In 1954, Klippel and Tomlinson [1] reported on a case of basal cell carcinoma of the anus. As they noted in their report, such a lesion had been reported in the literature only 12 times, and their case was the 13th. A review of the literature fails to reveal any case of basal cell carcinoma of the rectum; the following is a report of such a case.

F. J., a 64-year-old man, entered Firmin Desloge Hospital, St. Louis, March 4, 1951. For three to four months prior to admission, he had had pain in the rectum, with bleeding, tenesmus, and increased frequency of bowel movement. The pain was fairly constant and was increased with bowel movement. There was a weight loss of 7 lb. (3.2 kg.) following a transurethral prostatectomy done three weeks previously in another hospital.

The general physical examination revealed no abnormalities. Digital examination of the rectum revealed a 4- to 5-cm. ulcerated, firm tumor on the anterior wall of the lower rectum, with extension to the upper border of the anterior anal canal. The tumor was visualized, and biopsy was done.

The pathological examination of the biopsy specimen showed carcinoma of the rectum.

On March 10, a proctosigmoidectomy was done. Recovery was uneventful, and the patient was discharged from the hospital on March 28.

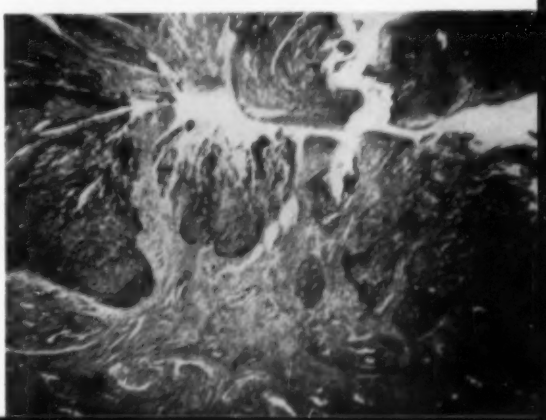
The pathological report is as follows. Gross Examination: The specimen (Fig. 1) consists of 29 cm. of bowel, rectum, and sigmoid. There is an ulcer crater 3.5×5×0.5 cm. in the wall of the lower rectum.

The edges of the crater are slightly raised and rolled and are firmer than the surrounding bowel tissue. On sectioning the crater is seen to extend for a distance of 1.5 cm. in depth, and its base and sides are surrounded by firm, pearly-white tissue for a depth of 1.5 cm. This pearly-white tissue is seen to extend through the entire thickness of the bowel at one point. Four lymph nodes are found in further examination of the specimen.

Fig. 1.—Gross specimen.

Microscopic Examination: Multiple sections through the ulcer crater reveal normal-appearing, stratified squamous epithelium on one side of the crater. However, about its margin and extending deep into the muscularis are clusters of relatively small, hyperchromatic, neoplastic, oval- to spindle-shaped cells which appear basilar in nature. The cells about the periphery of the clusters show palisading. Mitotic figures are fairly frequent. A

Fig. 2.—Squamous epithelium is seen right center, basal cell carcinoma on the left (low power).



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chronic inflammatory cell infiltration is seen in the stroma, composed, for the most part, of lymphocytes. This appears to be a very anaplastic sort of neoplasm and has the characteristics of a basal cell type (Fig. 2).

Examination of four lymph nodes reveals tumor tissue similar to that described above present in all nodes.

Diagnosis: Basal cell carcinoma of the rectum with metastasis to regional lymph nodes.

The patient was readmitted to the hospital on the urological service on Oct. 26, 1951, with anuria of two days' duration. A clinical diagnosis of metastases to the pelvic structures causing obstruction of both ureters was made. On further investigation the left kidney was found to be nonfunctioning, and apparently the right side of the urinary tract was recently obstructed. Therefore, on Nov. 5, a right cutaneous ureterostomy was done.

No further information is available concerning this patient after his discharge from the hospital after the last operation, but it is presumed that he died because of metastases.

SUMMARY

A case of basal cell carcinoma of the rectum is presented, and so far as can be determined no other such case is reported in the literature.

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Occult Carcinoma of Breast

Value of Roentgenography

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Diagnosis of mammary disorders calls for the exercise of considerable skill and experience. Often, only biopsy can decide the issue. Nevertheless, we believe that every effort should be made to evaluate the lesion prior to operation. A correct diagnosis, if it does nothing more, will at least enable the surgeon to plan his operation correctly. Here roentgenology has made a definite contribution.[4] But what can be said of those cases in which clinical studies suggest carcinoma of the breast and no mass can be discovered? It is evident that more than plain clinical acumen is required, and it is in these cases that an x-ray examination by finding, localizing, and diagnosing the tumor can be of the greatest assistance.

In the last four years we have examined over 1000 cases of breast disorders, of which 175 were carcinomas. Among them were five in which the carcinoma, although suspected, could not be felt and was only revealed on the x-ray film.

REPORT OF CASES

Case 1 (Fig. 1*A* and *B*: Duct Carcinoma).—One and a half years previously, this 39-year-old patient consulted a surgeon for eczema of the nipple. He could find no tumor but kept her under observation. One year later she went to a gynecologist, who noted the eczema but could find no mass. The patient returned to the surgeon, who prescribed an ointment. The eczema almost disappeared. Three months later a node appeared in the axilla. It was removed and the diagnosis of carcinoma was made, but there was no indication of the origin of the growth. X-ray studies of the breast revealed widespread punctate calcifications scattered throughout the breast along the course of the ducts. This type of calcification is pathognomonic of duct carcinoma even without the exhibition of an isolated tumor.[5] Pathologically, a duct carcinoma was found which had spread throughout the breast. Paraffin sections taken from many areas showed a lace-like or "comedo" type of carcinoma with numerous points of necrosis and calcification. The growth was mostly contained in the ducts. The nipple was extensively ulcerated, but no Paget cells were seen. The slicer sections

Fig. 1.—*A*, duct carcinoma showing widespread punctate calcifications following the line of the ducts. These alone are considered pathognomonic of malignancy.

B, slicer section of nodules scattered throughout the breast. Calcified necrotic tumor cells may be seen in the lumen of the ducts; reduced slightly from mag. × 3.4.

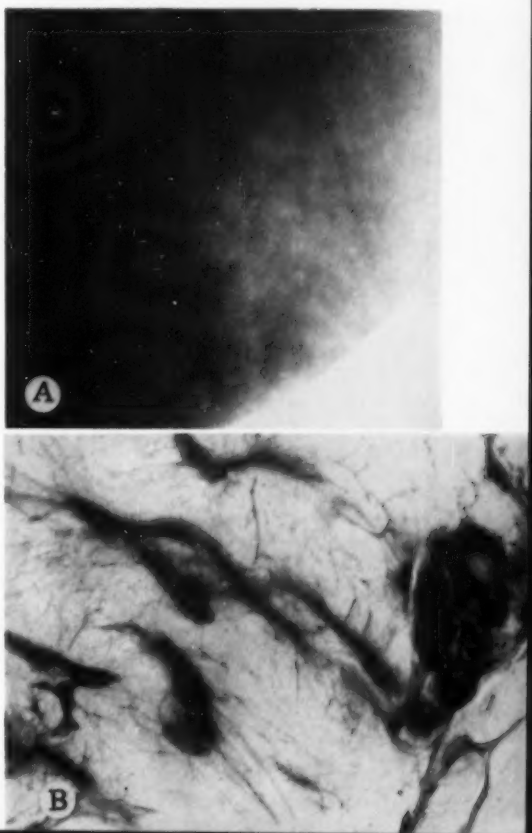

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Fig. 2.—*A*, medullary lymphoid carcinoma. An irregularly defined mass which shows coarse extensions characterizes this malignant lesion.

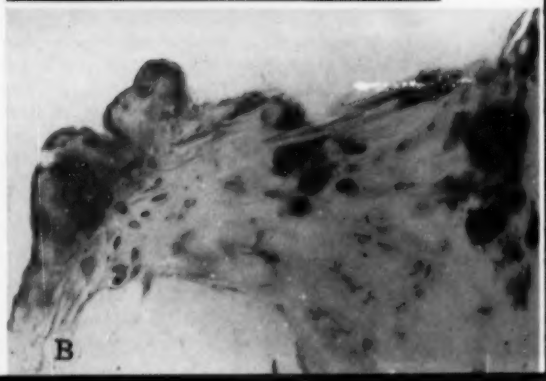
B, slicer section of a group of deeply staining nodules of carcinoma. A dilated duct containing secretion common at this age is visible beneath the nipple; reduced to 5/16 of mag. × 1.2.

showed enormous numbers of small, often partly calcified, nodules of growth. Many were so small that they could not be identified without the aid of the dissecting microscope. Between the tumors the ducts showed marked fibrosis.

Case 2 (Fig. 2*A* and *B*: Medullary Lymphoid Carcinoma).—This patient, 62 years old, com-

Fig. 3.—*A*, duct carcinoma. Two small spiculated tumors are seen beneath the nipple, and scattered widely through the breast are minute crystalline-like calcareous deposits pathognomonic of malignancy.

B, slicer section of a breast segment showing wide scattering of carcinomatous nodules. The nodule beneath the nipple was part of a larger mass; reduced to 5/8 of mag. × 1.7.



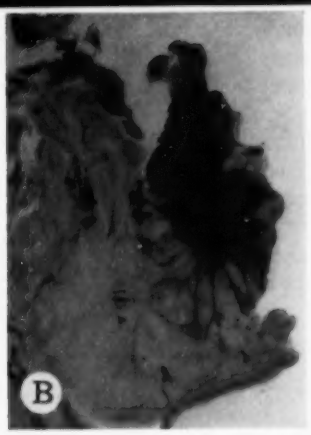


Fig. 4 *A*.—Carcinoma of the breast. An isolated lesion with dendritic margins characterizes this malignant process.

Fig. 4 *B*.—Slicer section of carcinoma; × 1.5.

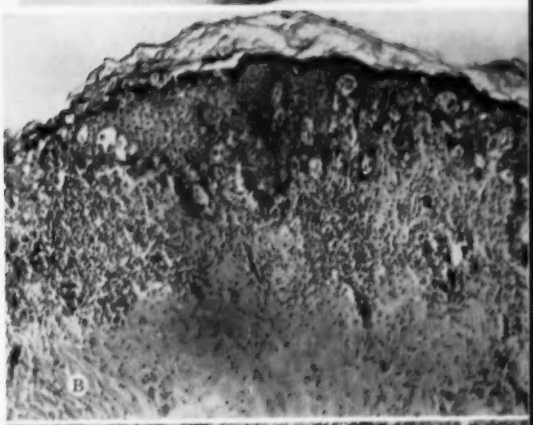
plained of a hard mass in the right axilla of two months' duration. A clinical diagnosis of malignant lymph node was made, but palpation of the breast revealed no pathology beyond slight thickening of the tissue of the upper outer quadrant.

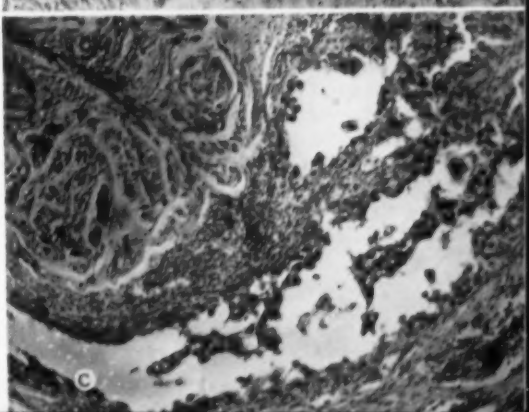
X-ray examination revealed a stellate mass about 8 mm. in diameter which was accurately localized

Fig. 5 *A*.—Duct carcinoma and Paget's disease. Localized infiltration is visible beneath the nipple in which is present minute calcific deposits indicative of duct malignancy.

Fig. 5 *B*.—Paraffin section of skin near nipple showing Paget's cells.

Fig. 5 *C*.—Duct carcinoma beneath the nipple.





deep in the upper outer quadrant of the breast. Malignancy of this lesion was suggested by its dendritic margins. At operation a soft indistinct tumor, 7×6 mm., was found at the site indicated on the x-ray film. Microscopically, it showed clumps and columns of large carcinoma cells surrounded by enormous numbers of lymphocytes. A similar tumor was seen in the node. The slicer section revealed a mass 4 mm. in diameter surrounded by other smaller nodules.

Case 3 (Fig. 3*A* and *B*: Recurrent Duct Carcinoma).—This patient, 51 years old, had been operated on 14 years previously for a tumor near the right nipple. The growth was removed locally, and this was followed by a course of x-ray treatments. The diagnosis at that time was duct carcinoma. The present symptoms began one month previous to admission, with discoloration of the skin at the site of the old operation and eczema of the nipple. A carcinoma was suspected, but beyond some induration in the nipple area which could have been due to the eczema and to fibrosis around the old scar, no tumor could be felt. She was then referred for x-ray examination.

Roentgenographically, two spiculated tumors, each about 2 cm. in diameter, were visible beneath and near the nipple. Associated with these tumors were widely scattered punctate calcifications pathognomonic of carcinoma.

Operation revealed a large carcinoma beneath the site of the previous incision. On pathologic examination, tumors were found through the greater part of the breast. Axillary metastases were present. Microscopically, the tumor was a duct carcinoma of the same type as the primary one removed 14 years previously.

Case 4 (Fig. 4).—This patient, 64 years of age, had interscapular pain for five days. A node was palpable in the right axilla, but nothing abnormal could be felt in the right breast. Moreover, the patient had no complaints referable to this breast and could not understand the necessity for its examination. X-ray studies of the chest, spine, and breasts were done. A tumor with dendritic extensions was found in the right breast; the other x-ray studies revealed nothing abnormal. A radical mastectomy was done after the frozen sections confirmed the presence of a malignant lesion of the right breast.

Case 5 (Fig. 5*A*, Fig. 5*B*, and Fig. 5*C*: Duct Carcinoma and Paget's Disease of the Nipple).—This 69-year-old patient complained of redness of the nipple for two years. There had been no pain and, according to the patient, no eczema or nipple discharge. No tumor had ever been felt. The left nipple revealed a small, cup-like depression. Near the outer margin of the areola was a circular, slightly raised serpiginous lesion. The surface was characteristic of a healed superficial ulceration. No palpable tumors were present. When first seen, two weeks before operation, the nipple was bright crimson. At the time of operation the color had faded.

The x-ray film showed an inverted nipple with thickening of the perifocal skin. A small infiltrative lesion was seen beneath the nipple, in which was scattered punctate calcifications indicative of malignant disease of the ducts.

At operation the central area of the breast, including the nipple, was removed down to the pectoral fascia. A radical mastectomy was not done because the patient was a poor surgical risk. Pathological examination revealed a hard mass 4 mm. in diameter attached firmly to the nipple. Slight nodularity was palpable along the line of the ducts. A second hard nodule lay beneath the edge of the areola. Paraffin section showed duct carcinoma and typical Paget cells in the epithelium.

COMMENT

What is usually meant by a case of occult mammary carcinoma is one in which the discovery of some remote symptom or sign such as localized pain over the spine or an enlarged axillary lymph node is the only evidence of disease, the primary lesion in the breast remaining undetectable clinically.

In this series of cases, this strict classification was followed. Excluded from this report were cases in which the x-ray examination revealed malignant breast lesions which were thought to be benign from the clinical findings. Such malignant tumors, though clinically appraised incorrectly, certainly are not to be regarded as occult.

Of 15 patients with occult tumor reported by Fitts and Horn, 4 had nothing but enlarged axillary nodes; the others had discharge from the nipple, dermatitis of the nipple, edema, or retraction of the skin or nipple.[2] These "sentinel" signs are not pathognomic. Not even retraction of the nipple can be regarded as too significant, since it frequently occurs in fibrosis and secretory disease. If the surgeons suspected the presence of a mammary mass, even if not clearly palpable, such cases were not regarded as occult tumors. In some of these cases, x-ray examination confirmed the presence of a tumor; in others, x-ray studies revealed other mastopathic causes for the palpable tumor.

Removal of a malignant axillary lymph node without discovery of a mass in the breast leaves the surgeon with only the alternatives of watchful waiting or the removal of the breast in spite of the absence of manifest disease. Halstead and Cameron * each reported three cases in which the former course was pursued; others have described the latter situation with amazement at the pathological findings in the amputated breast.† With the progress made in roentgenography of the breast, malignant lesions only a few millimeters in diameter can be detected on x-ray films.

SUMMARY

Of 175 carcinomas in a series of more than 1000 cases of breast disease, 5 cases of occult carcinoma were reviewed. The diagnostic criteria followed were the presentation of symptoms or palpable axillary lymph nodes with no clinical indication of a mammary neoplasm. In each of these five cases, positive x-ray findings led to a correct preoperative diagnosis. This experience suggests the value of making x-ray studies a part of the routine examination of the breast, especially in those cases presenting symptoms which could be associated with an occult mammary carcinoma.

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* References 6 and 1.

† References 2, 7, 8 and 9.

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Traumatic Axillary Aneurysm of Thirteen Years' Duration

Use of Venous Shunt

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We are reporting the case of a large axillary aneurysm of 13 years' duration, first, because of cardiac arrest which occurred at the first induction of anesthesia and did not occur at the time of surgical repair and, secondly, because a type of venous shunt was applied which in this arteriosclerotic syphilitic patient with cardiac irritability permitted a less traumatic and more rapid solution of the problem than would otherwise have been possible.

REPORT OF A CASE

Claude McK., a 63-year-old retired postman, entered St. Luke's Hospital on Sept. 15, 1953, for diagnosis and treatment of a pulsating mass which protruded in the left axilla and left infraclavicular space. History revealed that he had sustained a gunshot wound in this region 13 years previously and that he had at one time received treatment for syphilis. The mass had rapidly increased in size in the past four months, and the patient had recently noted pain in this region, together with tingling along the course of the ulnar nerve and weakness of the left hand. Physical examination revealed a Negro man with the aforementioned pulsating mass over which no palpable thrill or auscultatory bruit was present. The cephalic vein emptied on elevation of the arm. There was some atrophy and weakness of the left hand, with loss of sensation to light touch and pinprick along the distribution of the ulnar nerve. His blood pressure was 200/80 mm. Hg in both arms, and he had an enlarged heart with coronary insufficiency on the basis of arteriosclerotic heart disease. His blood cell count and urinalysis were normal, and the VDRL test was positive. Chemical examination of the blood revealed cholesterol, 256 mg.; albumin, 3.34 gm.; globulin, 5.46 gm., and a total protein of 8.80 gm. per 100 cc.

The increasing size and persistent pain of the mass demanded surgical relief. On Sept. 23, 1953, with the patient under general intratracheal anesthesia, the skin incision was about to be made when the anesthesiologist informed the surgeon that he could not obtain a blood pressure reading. The mass, which formerly had bounding pulsations, was silent. Anesthetic agents used were sodium thiopental (Pentothal), cyclopropane, succinylcholine (Anectine), and ether. It was obvious that the patient had either a cardiac arrest or a vascular collapse. Before the chest was opened for cardiac massage, two strong sharp blows were delivered to the precordium and 0.22 cc. of phenylephrine (Neo-Synephrine) was given intravenously. Within a few seconds the mass was again pulsatile and the systolic blood pressure rose to 110 mm. Hg. The operation was canceled, and the patient was returned to his room. On Oct. 10, 1953, induction was accomplished with nitrous oxide and ether, and intubation was aided by local spray of the vocal cords with 2% tetracaine (Pontocaine). A slight drop in blood pressure responded readily to 2 mg. methoxamine (Vasoxyl) given intramuscularly, and under continuous ether anesthesia the patient tolerated a six-hour procedure. Transection of the insertions of the pectoralis muscles exposed a large multilocular aneurysm tightly fused to the brachial plexus. Any attempt to remove this sac would probably have injured a portion of the plexus and greatly extended the time of the operation. For

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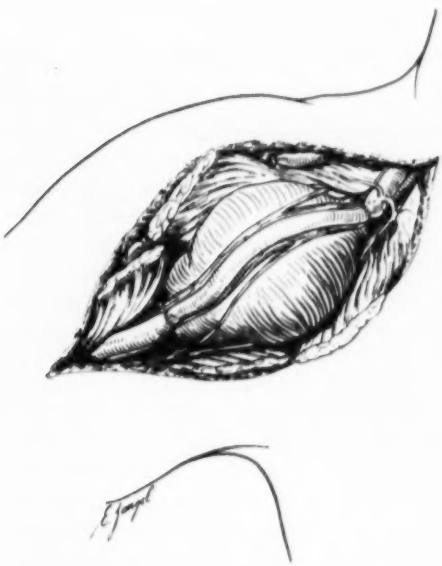
this reason the proximal and distal axillary artery was sectioned and those segments leading to and from the aneurysm were oversewn with 00000 Deknatel (silk) sutures. The continuity of the artery was then reestablished by bridging the 10 cm. gap with the left cephalic vein (Figure). Two drains were placed in the area of the wound; the muscles were sutured, and the wound was closed. Except for mild atelectasis on the third postoperative day, the hospital course was uneventful. He left the hospital on Oct. 15, 1953, without his presenting symptoms and with a strong radial pulse. On Feb. 20, 1954, the mass was continuing to shrink and oscillometric readings were normal. On April 2, 1954, the patient was asymptomatic and no mass could be palpated.



Multilocular aneurysm tightly bound to brachial plexus. Instead of being removed, it was sidetracked by sectioning the proximal and distal end of the artery and connecting the two stumps with a graft taken from the cephalic vein. Blood was seen to pulsate freely in this segment at the completion of the operation.

COMMENT

While it is most probable that the etiology of the aneurysm in our case was the gunshot injury, one notes that other possible causes of aneurysm were present: hypertension, arteriosclerosis, and syphilis. Each of these diseases may have favored the growth of the aneurysm. It is recognized that all aneurysmal sacs should be removed because of the dire results that may follow leaving them in situ. In this case, the previous history of cardiac irritability, the proximity of the brachial plexus, and the feasibility of a venous shunt around the sac seemed justifiable to simplify the operation as much as possible.

The role of anesthesia in producing cardiac arrest during the first trial needs brief comment. In a poor-risk patient, the avoidance of curare-like drugs and cyclopropane in favor of ether anesthesia after sufficient atropinization has long been our choice, and recent data by Beecher and Todd [1] have greatly strengthened our stand in regard to curare. Adequate atropinization means 1/75 to 1/60 of a grain of atropine (1 to 0.9 mg.), since this chemical vagotomy sufficiently suppresses noxious vagal reflexes to the heart.[2]

Aneurysms of the first and second portion of the subclavian artery were reviewed in 1950 by Temple.[3] Daniel [4] has pointed out that most aneurysms of such locations follow gunshot injuries and that syphilitic aneurysms at such sites are rare indeed, occurring only once in each 581 aneurysms diagnosed at the Charity Hospital in New Orleans. In 1942, E. Rehn [5] treated subclavian aneurysm by transplantation of a vein. Janes [6] recently reported excision of a recurrent syphilitic aneurysm of the brachial artery after preliminary cervicothoracic ganglionectomy.

SUMMARY

The case of a 63-year-old arteriosclerotic and syphilitic patient who suffered a gunshot wound in the region of the left subclavian artery is described. This patient suffered a cardiac arrest on induction of anesthesia with thiopental (Pentothal) sodium, cyclopropane, succinylcholine (Anectine), and ether. After a second induction with nitrous oxide and ether anesthesia, sufficient atropinization, and tetracaine (Pontocaine) spray to the larynx a smooth anesthesia ensued. Instead of a huge aneurysmal mass being resected, it was sidetracked by placing a 10 cm. segment of the cephalic vein between the sectioned

proximal and distal segments of the axillary artery. Patency was restored, and the large mass gradually became impalpable.

122 South Michigan Ave. (3)

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Carcinoma of Jejunum in Intestinal Polyposis with Oral and Digital Melanosis

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R. J. KORN, M.D.
and
H. B. SAICHEK, M.D., Omaha

Peutz apparently was the first to call attention to the curious association of intestinal polyposis with melanin pigmentation of the lips, oral mucosa, and skin of the digits. Jeghers and co-workers found 12 proved and 9 possible cases in the literature, to which they added 10 of their own. Since then, additional cases have been recorded, especially recently, suggesting that the disease is either becoming commoner or is being more frequently recognized. Strangely enough, the occurrence of carcinoma in the polypoid lesions of the bowel has not been especially emphasized in the cases reported.

The case herein reported is typical of the syndrome. It is reported not only to add to the recorded number of these cases but also to emphasize the potential malignancy of the polypoid mucosa. Also included are some reflections on the care of these unfortunate persons.

REPORT OF A CASE

E. H. K., a 23-year-old white man, was admitted to the hospital July 16, 1953, complaining of intermittent abdominal cramps of two years' duration. He dated the onset of the cramping at October, 1951, during his military service. At that time he was examined in a dispensary, told that he had prostatitis, and treated with prostatic massages. The symptoms did not improve, but he continued to receive prostatic massages. In spite of this treatment, the abdominal cramping grew worse and finally became associated with vomiting. He noted that the cramps were worse after meals and were relieved by emesis. With these episodes he began to notice the development of "bulges" in his abdomen, which moved about and were related to the cramping sensations. His appetite palled; he became easily fatigued, felt weak, and noted an increasing pallor.

Because of the aggravation of these symptoms he saw a physician, who hospitalized him, administered a blood transfusion, and, on the basis of gastrointestinal roentgenograms, made a diagnosis of round worm infestation. He was therefore treated with a vermifuge. In spite of this treatment, his symptoms continued, and he then applied for hospitalization at this institution. His past history was significant only in that he was jaundiced for a few days after birth, had an operation to release an obstruction at the "end of his stomach" at the age of 4 days, and at the age of 15 years had an appendectomy because of abdominal cramps.

Physical examination revealed a tall, thin, chronically ill, white man who appeared to be of the stated age. He was blond, blue-eyed and freckled. However, about the lips and extending onto the buccal mucosa were smaller, darker spots which appeared to differ from the freckles in his skin (Fig. 1). Similar spots were noted on the dorsum of the hands and fingers (Fig. 2), and there was one spot on his right big toe. Well-healed right lower quadrant and high epigastric scars were found in the abdomen. There was a visible and palpable mass in the left lower quadrant, which was somewhat movable. Peristalsis could be seen through the thin abdominal wall. It should be recorded that this mass was inconstant; on some days it was palpable; on other days it was not. It was believed, because of its shape, mobility, and inconstancy, to be a recurring intussusception. Laboratory examinations were generally unrevealing. The most significant finding was that of a rather marked anemia of less than 3,000,000 RBC and less than 7 gm. of hemoglobin. The hematocrit reading was 29%, and examination of the bone marrow revealed it to be hyperplastic, consistent

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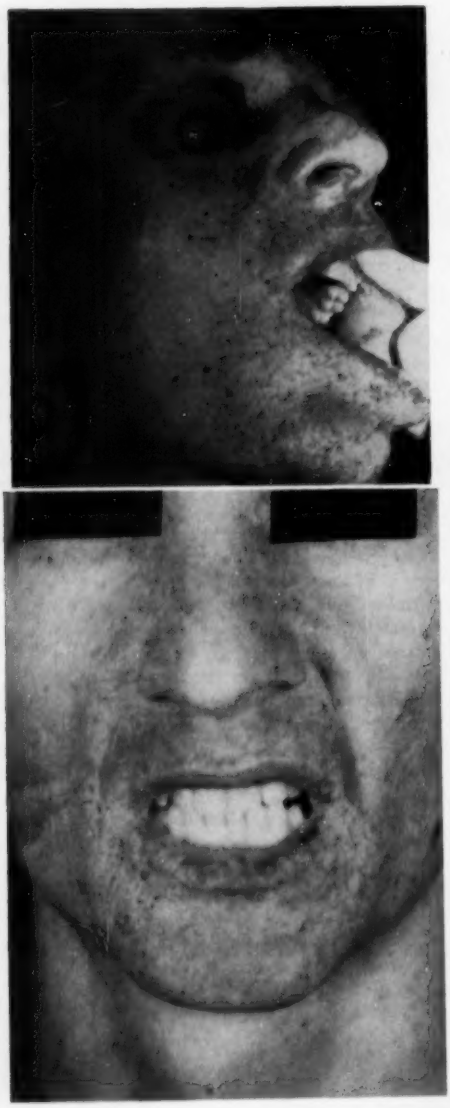
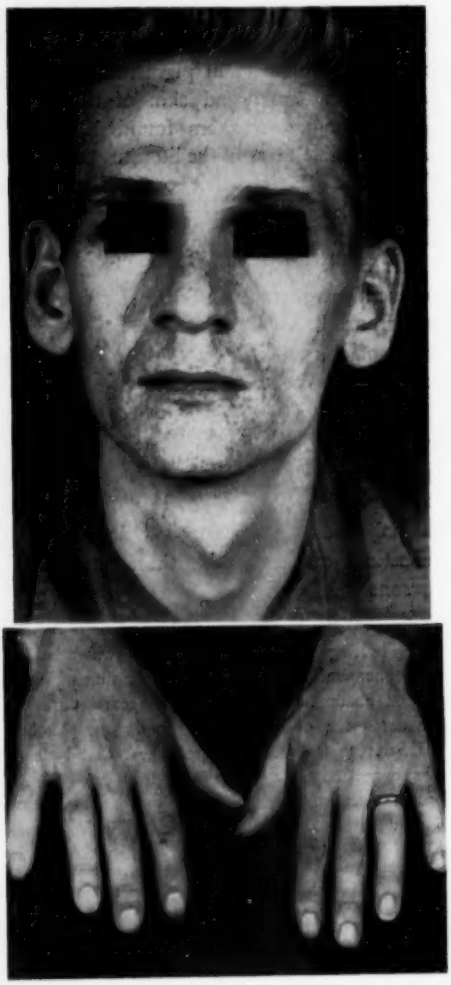


Fig. 1.—Pigmentation of the lips and oral mucosa, which differentiates this type of pigmentation from ordinary freckles and which is pathognomonic of the syndrome.

with chronic bleeding. Careful roentgenographic studies suggested a slightly enlarged spleen, but there was no definite evidence of disease in the small bowel, although the possibility of polyps was entertained. Contrast studies of the colon, however, revealed definite polyps in the region of the splenic flexure, as well as a polyp in the cecum (Fig. 3). On the basis of the available findings, a diagnosis of intestinal polyposis with oral and digital melanosis (Peutz-Jegher syndrome) was made.

Because of the chronic hemorrhage and recurring intussusception a laparotomy was performed on Aug. 11, 1953, after suitable preoperative preparation. At operation the spleen was found to be approximately four times normal in size. The other abdominal viscera, with the exception of the gastrointestinal tract, were not remarkable. Careful palpation of the stomach and duodenum showed no evidence of polyps. However, shortly below the ligament of Treitz a polyp was palpated and re-

Fig. 2.—Perioral distribution of the pigment, which is suggestive of the syndrome, and the pigmentation of the hands. This is the typical facies as found in other reports of this syndrome.



moved through an enterotomy. The entire bowel was examined by palpation, and all palpable polyps were removed through enterotomies. The polyps all had long pedicles, and, whenever feasible, a

Fig. 3.—Roentgenographic studies of the bowel, showing a nonrevealing small bowel pattern. The arrow in the right lower quadrant indicates the inverted appendiceal stump. The air contrast enema study reveals polyps in the region of the sigmoid, as indicated by the arrow.

single enterotomy was used to amputate two or more polyps. Approximately a dozen polyps were removed in this manner from small bowel and

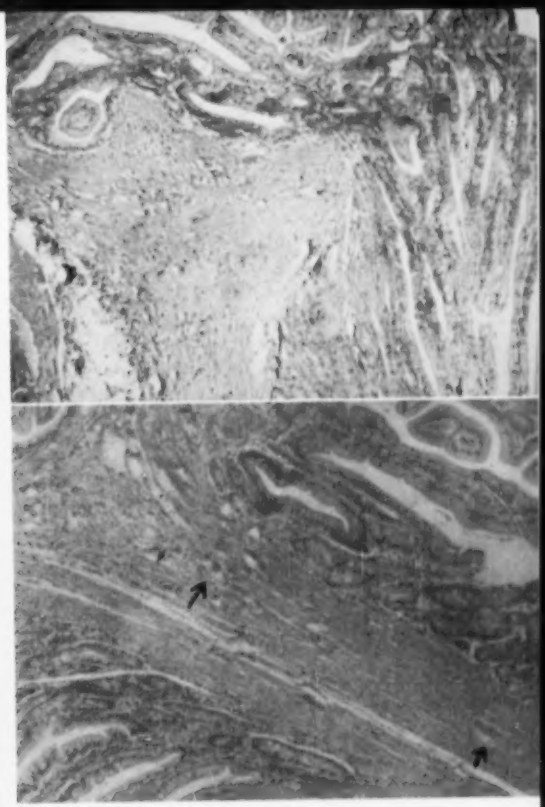
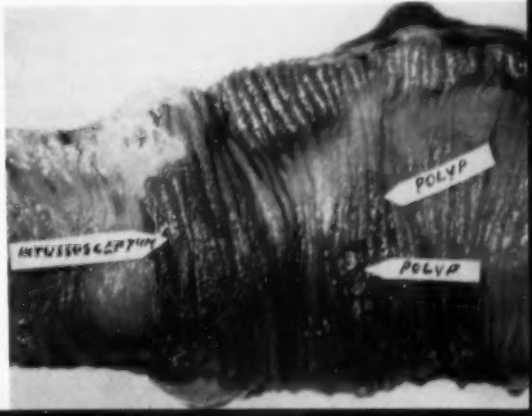


Fig. 4.—Histopathologic sections showing a hyperplastic polyp above and a malignant polyp below. The arrows indicate carcinoma cells invading the stalk of the polyp.

colon. In the cecum a nodule was palpated which appeared to be a mucocele in an appendiceal stump. This was excised by means of a diamond-shaped incision. The patient recovered from his operation in a satisfactory manner immediately after operation.

Histopathologic study of the surgical specimens revealed most of them to be histologically benign polyps of the small intestine and colon. The polyp from the terminal ileum, however, was described as being a "potentially malignant type having a tendency to hyperchromatic glandular epithelium

Fig. 5.—Gross surgical specimen removed during treatment for intussusception. Notice the small polyps in the mucosa which suggest the wide mucosal involvement.



which is slightly variable. The variation is not sufficiently marked so that this may be considered a malignant lesion." A polyp from the lower jejunum was diagnosed as adenocarcinoma with invasion of the polyp stalk (Fig. 4).

On the fifth postoperative day, after nasogastric suction was discontinued, he complained of cramping. After feedings were started, a mass was again discovered in the midline of the abdomen. When intestinal decompression was accomplished, the mass disappeared and the cramping was relieved. However, he could not eat without a recurrence of his symptoms. A diagnosis of recurrent intussusception was made, and, somewhat reluctantly, he was rescheduled for laparotomy on Sept. 17, 1953. At this operation an extensive intussusception was discovered. It was chronic, could be only partially reduced, and apparently had developed at the site of one of the enterotomies. Segmental resection of the involved area was accomplished, and an end-to-end anastomosis was done. Recovery from this operation was uneventful. Histopathologic study of the resected intussusceptum revealed that it had indeed occurred with a previous enterotomy as the leading edge of the intussusceptum, but of greater interest was the discovery of two small, benign polyps which were too small to be felt by external palpation (Fig. 5).

He was discharged on Sept. 29 (12th p. o. day) and returned in 30 days for examination, at which time he had gained about 15 lb. (6.8 kg.) and was feeling well. He was seen again three months later, at which time he had gained 25 lb. (11.3 kg.), looked and felt well, and had no complaints.

COMMENT

In reviewing the cases previously reported, one is impressed by the remarkable similarity among them. Indeed, the illustrations in the several articles are almost identical so far as pigment distribution is concerned. This constant association of a specific oral and cutaneous pigment pattern with gastrointestinal polyposis must be important, although its exact significance has not been discovered.

The disease is congenital and represents an inherited defect of the germ plasm. When the characteristic pigment pattern is discovered in a person, constant, regular, medical observation is indicated. Medical observation is directed to discovering abdominal symptoms of partial obstruction or recurrent intussusception. It is also important to discover evidence of gastrointestinal bleeding, which is demonstrated by a secondary anemia and evidence of blood in the stool. In either event (intussusception or gastrointestinal bleeding), laparotomy is indicated, and all identifiable polyps should be removed by enterotomy. Gastrointestinal roentgenograms are important in locating gastric and colon polyps but are of little help in locating polyps of the small bowel. For this reason laparotomy should be done if the above-named symptoms are present, even if the roentgen evidence is unrevealing. The polyps should be removed and individually identified as to site of origin and referred for histologic study. This may be important if malignant degeneration is discovered in one of them.

Polyposis of the gastrointestinal tract is a notorious precancerous condition. The importance of this syndrome in cancer case finding requires continual reemphasis. Although malignant degeneration in persons with this disease has been described, it would be interesting to discover how many such cases will terminate as cancer. One would expect that the incidence would be very high if long, careful follow-ups are done.

It is quite probable that the tendency to polypoid degeneration is an inherited characteristic of the gastrointestinal mucosa of these persons. It is unlikely that the tendency will be favorably influenced by polypectomy. The resected intussusception in the reported case, carrying two externally unidentifiable polyps, is illustrative of the futility of expecting to excise all polyps at one laparotomy. Obviously only the larger polyps are discovered by palpation.

Correct cancer prophylaxis would require total ablation of the tissue which is prone to malignant degeneration. When the suspect lesions, however, involve the entire gastrointestinal tract, the principle must be modified. Early laparotomy and enterotomy is a minimal therapeutic approach to these persons. The principle of the "second look" laparotomy as advocated by Wangensteen would seem to have merit, especially in those instances in which malignant degeneration in a polyp has occurred. In any event, the pa-

tient must be informed of the nature of his disease and of the need for persistent medical supervision.

SUMMARY

A case of intestinal polyposis with cutaneous and oral melanosis is reported in which one of the jejunal polyps had undergone malignant degeneration. Considerations in the diagnosis, treatment, and management of these cases are discussed.

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War Injuries of Heart and Mediastinum

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In a group of 2811 chest casualties of the Korean conflict treated at Tokyo Army Hospital from August, 1950, to March, 1953, 117 had injuries to heart and mediastinum. This is an incidence of 4.2%. The small number is due, no doubt, to the high initial mortality resulting from such wounds.

HEART AND PERICARDIUM

Injuries to the heart and pericardium are considered in one group, since both are so often damaged at the same time. Approximately 90% of such injuries were caused by penetrating injuries with the retention of foreign bodies; 10% were due to perforating injuries.

Forty-two patients developed pericardial effusions which were usually due to the presence of small metallic foreign bodies within the pericardium. The effusion developed any time from shortly after injury to six weeks later. The patient experienced severe precardial pain, a rise in temperature, tachycardia, and shortness of breath. Upon physical examination, the heart sounds were distant. X-ray examination showed the heart shadow to be enlarged, and the electrocardiogram revealed pericardial changes.

These patients were treated with pericardiocenteses and antibiotics. For pericardiocentesis, the head of the bed was raised to an angle of 80 degrees, and the pericardial sac was approached through the fifth interspace about 5 cm. from the left border of the sternum. A long 15-gauge needle with a short bevel was used, and as much fluid as possible was removed at each aspiration, the total varying from 300 to 1800 cc. In approximately 50% of the cases, pyogenic organisms were obtained from culture of the fluid removed at the first or second aspiration. Sensitivity tests were run routinely and the antibiotic of choice was administered systemically and locally.

Foreign bodies of 0.5 cm. or more in their greatest dimension were removed routinely. Right or left posterolateral or anterior approaches were used for the thoracotomy. The pericardium was opened and the foreign body removed. Usually the object was easily located, but at times it was most difficult even with the aid of the Berman locator. The pericardium was partially closed with 0000 silk interrupted sutures, and the chest closed in layers and drained with two intercostal tubes connected to water-seal bottles.

Early in the war, small foreign bodies within the pericardium were not removed when they did not give rise to symptoms or when the pericardial effusion subsided after treatment with pericardiocenteses and antibiotics. However, as our experience increased, we began to doubt the advisability of this policy and later changed it.

Prior to February, 1953, 10 patients previously discharged as cured and subsequently returned to duty were hospitalized with recurrences of fever, precardial pain, pericardial effusion, and pleural effusion. Four of these had positive blood cultures. The flare-ups occurred from 4 to 26 months after injury. Since then two cases have come to our attention at Walter Reed Army Hospital, making a total of 12 known cases.

When thoracotomy was performed for removal of these small foreign bodies, the pericardium was found thickened, fibrotic, and adherent to the epicardium. Positive cultures were obtained from the pericardial fluid present in six patients. In effect, all the factors for development of a constrictive pericarditis were present.

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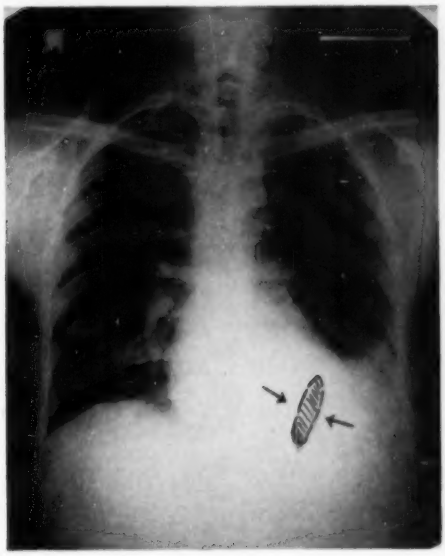

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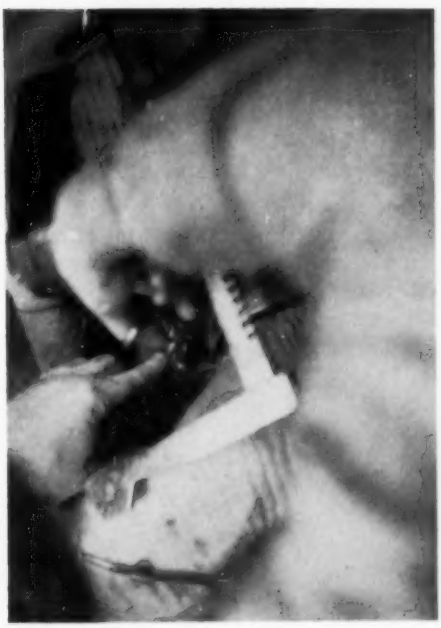

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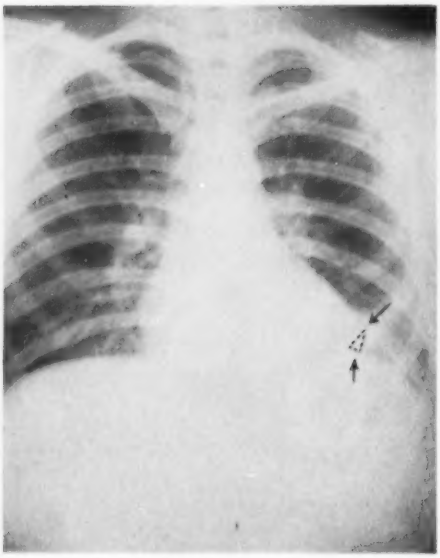
D

Fig. 1.—*A*, posterior-anterior view of chest showing large bullet in the heart, with left pleural effusion; *B*, same case—lateral view; *C*, photograph taken during operation showing bullet being removed; *D*, postoperative x-ray. (*A*, *B*, and *D* courtesy of Armed Forces Institute of Pathology; Neg. Nos. [*A*] A. M. S. 2802 22, [*B*] A. M. S. 2802 30, [*D*] A. M. S. 2802 20.)

In consideration of these findings it would seem advisable to attempt to remove all foreign bodies as soon as possible.



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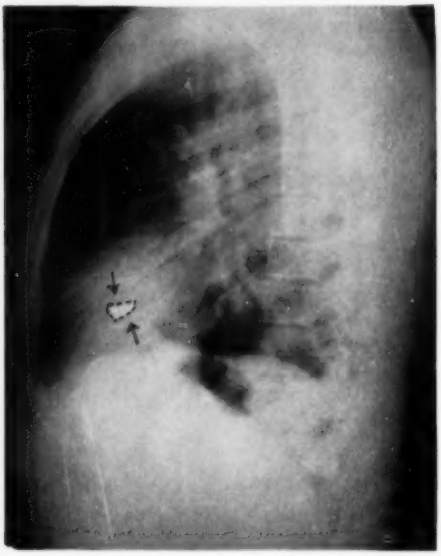

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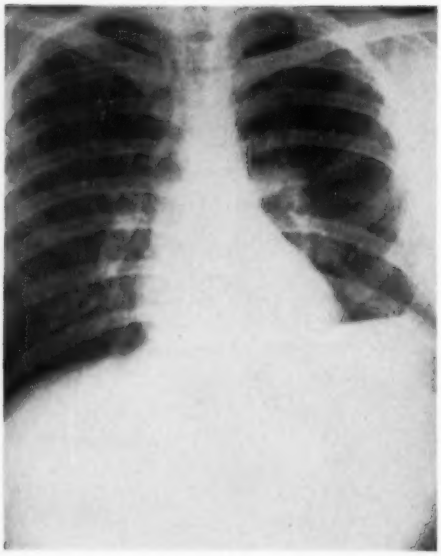


C

Fig. 2.—*A*, posterior-anterior view of chest showing shell fragment in heart; *B*, same patient—lateral view; *C*, postoperative film, (Courtesy of Armed Forces Institute of Pathology; Neg. Nos. [*A*] Amst. 13200—B1—6/4/53, [*B*] Amst. 13200—A1—6/4/53, [*C*] Amst. 13200—0—6/4/53.)

MYOCARDIUM

Nineteen patients in our series had foreign bodies in the myocardium. Fifteen were shell fragments and four were bullets (Figs. 1 and 2). A number of these patients had associated hemopericardia and pleural effusions. An attempt was made to remove all foreign bodies because of the danger of embolism, either from the foreign body or an associated thrombus, of bacterial endocarditis, myocardial rupture or hernia, recurrent pericardial effusions, and, in some cases, the so-called "cardiac neuroses."

The approach used was determined by the location of the foreign object. In all but three cases a left thoracotomy with a posterolateral or anterior incision was used. In three cases the metallic foreign bodies were in the right auricle or ventricle, and a right thoracotomy was used. A 10-cm. incision was made in the pericardium overlying the object. Usually the pericardium was adherent to the epicardium and required blunt dissection for separation. The foreign body was located and two or three U-shaped sutures of 000 nonabsorbable surgical (silk) were placed around it. The object was removed, the sutures tightened, and the bleeding controlled. In three cases

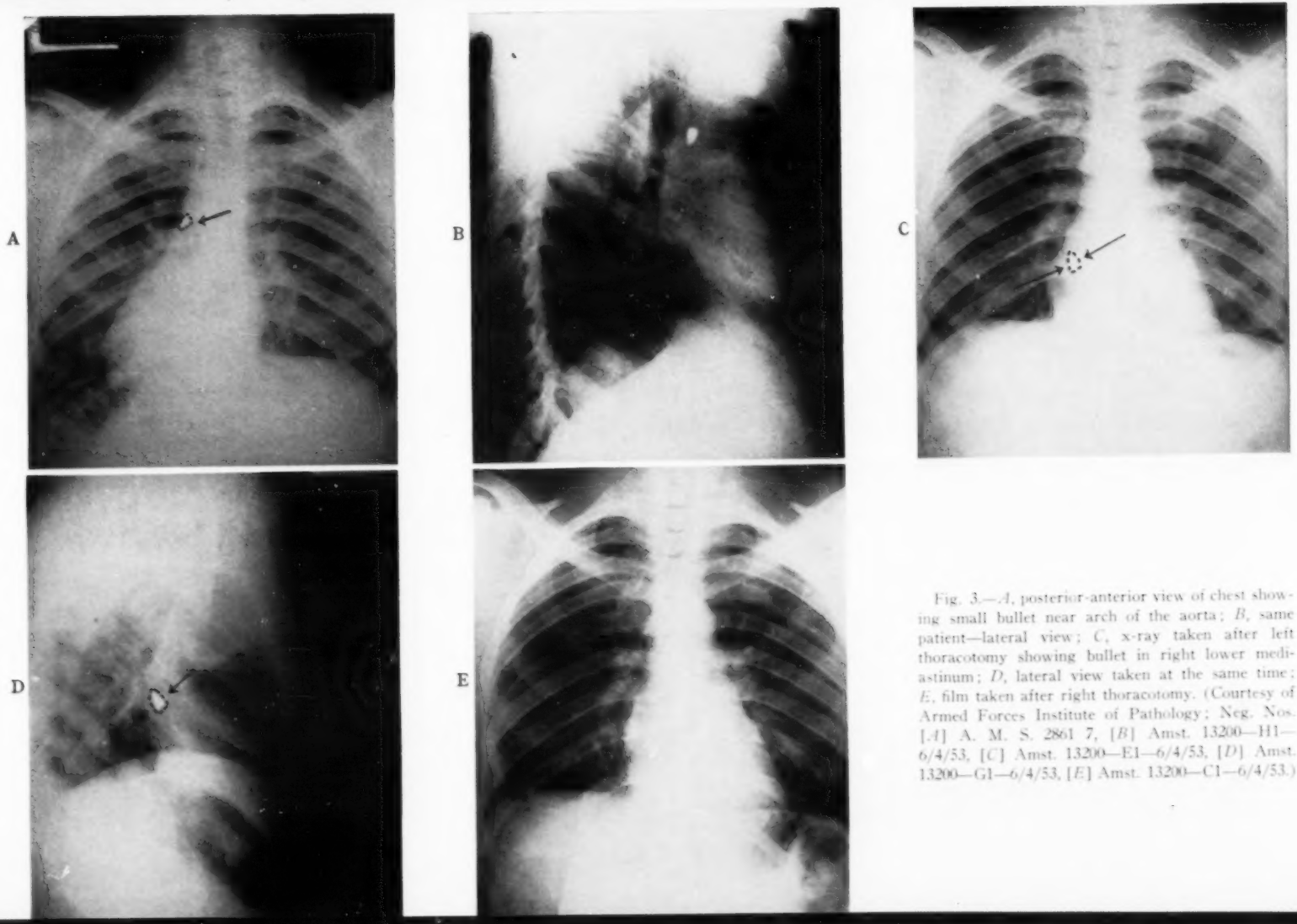


Fig. 3.—*A*, posterior-anterior view of chest showing small bullet near arch of the aorta; *B*, same patient—lateral view; *C*, x-ray taken after left thoracotomy showing bullet in right lower mediastinum; *D*, lateral view taken at the same time; *E*, film taken after right thoracotomy. (Courtesy of Armed Forces Institute of Pathology; Neg. Nos. [*A*] A. M. S. 2861 7, [*B*] Amst. 13200—H1—6/4/53, [*C*] Amst. 13200—E1—6/4/53, [*D*] Amst. 13200—G1—6/4/53, [*E*] Amst. 13200—C1—6/4/53.)

the foreign bodies were lodged in the interventricular septum, and efforts to remove them were unsuccessful. Many of these patients had normal electrocardiograms after removal of the foreign body.

Eighty per cent of the patients who had pericardial effusions developed left pleural effusions and about 50% developed bilateral pleural effusions. All these patients required thoracentesis which invariably yielded sterile straw-colored fluid. As soon as the pericardium decreased in size, the pleural effusion subsided and did not recur, which would indicate that the pleural effusion was due to pressure on the lung parenchyma.

One patient died of cardiac tamponade before an operation could be performed. This was the only death in the group.

MEDIASTINUM

Mediastinal injuries causing the most concern are those which result in retained foreign bodies. Unless some vital structure is injured, the mere passage of a missile through the mediastinum does not, as a rule, result in a mediastinitis. If mediastinitis develops, it is mild and resolves itself.

In our series, 32 patients had foreign bodies retained in the mediastinum. Seventy per cent of these were shell fragments and 30 per cent were bullets. A large percentage of the shell fragments were accompanied by cloth, pieces of bone, and other extraneous material. Sixty-five per cent of the wounds were infected.

A right or left approach, depending upon the location of the object, was used for thoracotomy to remove the foreign bodies. The mediastinal pleura was opened and the foreign body located and removed. In cases in which infection was present, the pus was aspirated and the abscess cavity washed with sterile saline. One gram of streptomycin and 500,000 units of penicillin was instilled in the mediastinal space which was left open into the pleural space. The chest was closed in layers and drained with two intercostal drainage tubes connected to water-seal bottles.

One of the difficulties encountered in removing foreign bodies from the mediastinum is that these objects tend to move about in the mediastinal space. Often the object is tentatively located and the approach determined only to find, on exploration, that the object has moved. In one patient, the foreign body was located in the left upper mediastinum (Fig. 3) and a left thoracotomy was performed. However, when the mediastinal pleura was opened, the object could not be located. It had apparently been lodged at the arch of the aorta, but during the operation it had slipped down into the extreme lower right mediastinum, where it was inaccessible from the left thoracotomy. The chest was closed, and three weeks later the object was removed through a right thoracotomy.

In several of our patients, the metallic foreign body entered the lower part of the neck, and an abscess developed around it. The infection, along with the foreign body, migrated downward into the superior mediastinum. In these cases, the abscess was first drained through the lower part of the neck. Usually the patient's condition improved sufficiently to permit the performance of thoracotomy and removal of the foreign body within a few days.

There were no deaths in this group.

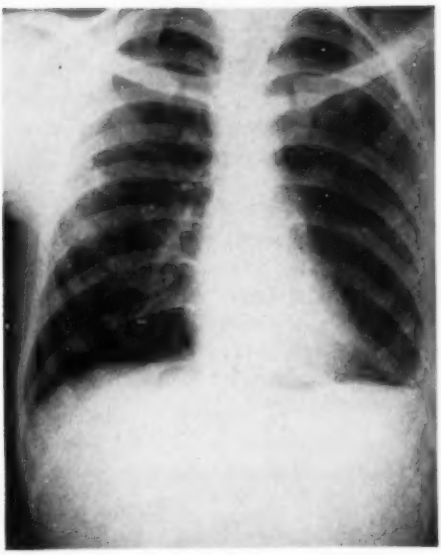
ESOPHAGUS

Nine patients had perforations at different levels of the esophagus. Coincidentally, all these injuries were results of penetrating wounds caused by shell fragments. Most of these patients had a complicating mediastinitis and empyema which had been drained prior to admission to Tokyo Army Hospital. Before repair of the esophageal defect, the patients were fed intravenously and through a Levine tube.

The defects were repaired through a right or left thoracotomy, whichever approach offered the best exposure. The defect was located and the esophagus repaired in two layers, the mucosa and muscular layer being sutured separately with 0000 nonabsorbable surgical (silk) interrupted sutures. The chest

A

B



C

Fig. 4.—*A*, posterior-anterior view of chest showing bullet lodged in descending aorta; *B*, same case—lateral view; *C*, postoperative film. (Courtesy of Armed Forces Institute of Pathology; Neg. Nos. [*A*] Amst. 13200—C—6/4/53, [*B*] Amst. 13200—F—6/4/53, [*C*] Amst. 13200—J1—6/4/53.)

was closed in layers and drained with two intercostal tubes connected to water-seal bottles.

The patients were allowed to drink fluids on the 4th or 5th postoperative day and to eat soft foods on about the 10th day after operation.

AORTA

Eight patients suffered injuries to the aorta. Three of these injuries were produced by bullets and five by shell fragments. All of them were penetrating wounds. Five were of the descending thoracic aorta (Fig. 4) and three were at the arch.

In three cases, there was a marked contusion of the aortic wall, but the wall was not perforated. The wall of the aorta was weakened at the point of injury, and apparently the adventitia and part of the media were damaged. The foreign body was removed at thoracotomy and the contused area was reinforced with 0000 silk mattress sutures.

Five patients had injuries to the aorta with perforation of the wall. Prior to removal of the foreign body, about 5 cm. of the aorta on each side were mobilized. Two oiled umbilical tapes were passed around the aorta, one above and one below the foreign body, as a precautionary measure. At the time the ob-

ject was removed, marked bleeding occurred, which was controlled either by finger pressure or Potts clamps. The defects were closed with 0000 silk mattress sutures and the chest closed in the usual manner with two intercostal drainage tubes.

THORACIC DUCT

Five patients received injuries to the thoracic duct. Three of these were the result of crushing injuries to the chest, and two were caused by penetrating wounds of the mediastinum. In four patients, the chylothorax developed on the right side and in one on the left. The left chylothorax was the result of a penetrating wound of the upper mediastinum. The injuries in the remaining four were in the right lower part of the chest. If the defect does not seal off spontaneously or is not corrected surgically, the nutrition of the patient is markedly impaired because of the loss of fat and fluid.

The chief symptom of a thoracic duct injury is the accumulation of large amounts of chyle in the pleural space which causes circulatory and respiratory embarrassment. Another feature of diagnostic importance is the milky color and consistency of the fluid aspirated from the chest. Also, on chemical analysis, the fat content is found to be high.

It was our policy to treat these patients conservatively, first with repeated thoracenteses and antibiotics given both locally and systemically. This treatment sufficed in two of our cases, and the chyle fistula apparently closed spontaneously. In the remaining three, the thoracic duct had to be ligated. Good exposure was obtained with a right thoracotomy. The lower end of the thoracic duct was easily located because of the steady flow of chyle pouring from it. Both ends of the duct were ligated, and the chest was closed in the usual manner.

All of these patients made uneventful recoveries, and collateral chyle channels were soon established.

TRACHEA

Five patients received major injuries to the tracheal wall. All of these were due to shell fragments. The metallic foreign body was removed in all cases, because it caused symptoms such as hemorrhage, emphysema, and infection. One of the foreign bodies was removed through the lower neck approach and the remaining four through left thoracotomies. The defects varied in size from 0.5 to 1.5 cm. in length and were repaired with 0000 silk interrupted sutures.

All of these patients made uneventful recoveries and were returned to duty.

VENA CAVA

In this series, two patients suffered injuries of the inferior vena cava and one of the superior vena cava. Two were due to bullets and one to a shell fragment.

All three of the foreign bodies were removed through left thoracotomies. The objects had perforated the wall of the vessel and were found to be plugging the opening at the time of removal. The vena cava was dissected free and Potts clamps were placed above and below the foreign body. The object was removed and the defect closed with 0000 silk mattress sutures. The mediastinal pleura was left open and the pleural space was drained with two intercostal tubes.

SUMMARY

During the Korean conflict, 117 patients with injuries to the heart and mediastinum were treated at Tokyo Army Hospital, the chest surgical center for the Far East Command. This represents 4.2% of the total of 2800 serious thoracic casualties admitted. The breakdown of the injuries is as follows:

Pericardial effusions	42
Foreign bodies in heart	19
Foreign bodies in mediastinum	32
Esophageal injuries	9
Injuries to aorta	8
Injuries to thoracic duct	5
Injuries to trachea	5
Injuries to vena cava	3

The methods used in dealing with these injuries and the results obtained are discussed.

The surgical mortality in this series was 0% and the over-all mortality was 0.8%.

Renal Displacement and Rotation During Retroperitoneal Pneumography

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RICHARD D. AMELAR, M.D.
and
ABRAHAM ORRON, M.D., New York

The epoch-making work of Rivas,[1] reported in November, 1950, added to the armamentarium of radiologists and urologists a new diagnostic technique, which may be termed "presacral retroperitoneal pneumography."

In the past three years at French Hospital, we have used this method of outlining the perirenal spaces in many cases with complete satisfaction and no untoward effects. We should like to report on a case of renal displacement and rotation which occurred as a result of the retroperitoneal insufflation of oxygen. To our knowledge, this phenomenon has not been previously observed, and, since this finding may give rise to misinterpretation, we feel that it should be recorded.

Fig. 1.—Retroperitoneal pneumogram showing right kidney lying in horizontal position. Antero-posterior view.

REPORT OF A CASE

The patient, a 33-year-old housewife, was admitted to the Medical Service seven weeks after the normal, full-term, spontaneous delivery of an infant weighing 7 lb. 10 oz. (4592 gm.). Examination in the follow-up clinic revealed persistent hypertension, and she was admitted for investigation. In the course of the work-up, she was seen by the Urological Service to rule out the kidneys and adrenals as the cause of her hypertension. Physical findings, except for moderate obesity, were essentially negative. No abdominal organs or masses were palpable.

Presacral retroperitoneal pneumography was performed, with the introduction of 1000 cc. of oxygen in 50 cc. increments into the retroperitoneal space. The left kidney and suprarenal space were found to be normal. On the right side, the suprarenal space appeared normal with no adrenal enlargement. However, the position of the right kidney was seen to be markedly abnormal, with the lower pole displaced upward and medially, as if by a mass extrinsic to the kidney. No mass could be made out on the x-ray, and therefore a retroperitoneal tumor of fatty nature—either a lipoma or a liposarcoma—was considered, and it was believed that exploration of the right retroperitoneal space should be advised.

Repeated x-rays four days later, after some absorption of the insufflated oxygen had taken place, revealed the kidney to be back in normal position. It became apparent that the insufflation of oxygen caused the right kidney to rotate 90 degrees, and that there was no retroperitoneal tumor.

From the Urological Service of French Hospital.

SUMMARY

A case is reported in which renal displacement and rotation through 90 degrees occurred as a result of the presacral retroperitoneal insufflation of 1000 cc. of oxygen.

Fig. 2.—Retroperitoneal pneumogram showing lower pole of right kidney displaced upwards. Lateral view.

Fig. 4.—AP view of abdomen taken four days later, showing right kidney to have returned to normal position after absorption of most of insufflated oxygen.

Fig. 3.—Retrograde pyelography combined with retroperitoneal pneumography, showing 90 degree rotation of right kidney. Anteroposterior view.

Fig. 5.—Subsequent bilateral retrograde pyelography, showing right kidney in normal position as contrasted to Figure 3.

The radiologist and urologist should be aware of the possibility of this phenomenon, so as to avoid misinterpretation.

330 West 30th Street.

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Importance of Hair Color to Successful Skin Transplantation

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and
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The fate of skin homografts transplanted among inbred strains of mice may be governed by genetic factors similar to those which are generally accepted as determining the failure or success of tumor grafts.* Various inbred strains of mice having different coat colors were selected as donors for homografts. A difference in the color of recipients would thereby give an unquestionable contrast to the skin graft and be an aid in the determination of viability.

METHODS AND MATERIALS

Full-thickness skin, approximately 70 to 80 mg. in weight and 1 sq. cm. in area, was grafted on 168 mice 6 weeks old. The technique for grafting and the criteria for viability of transplants have been described in previous publications.† The inbred strains of mice, CBA, C_3H, and C_{57}, were originally obtained from Dr. J. Bittner ‡ and maintained in our laboratories by brother and sister matings. The hair color for these mice is brown for the CBA and C_3H, black for the C_{57}, and white for the C strain. At the time of this report a majority of the grafts have been observed from 10 to 12 months.

From the Departments of Microbiology and Surgery, University of Kansas Medical Center.

This work was supported in part by a grant from the National Cancer Institute, National Institutes of Health (C-1827).

* References 1 to 4.

† References 5 and 6.

‡ Department of Physiology, Division of Cancer Biology, University of Minnesota.

RESULTS

Three series of donor-recipient combinations were used.

Experiment 1.—Recipient and donor animals for skin grafts were of the same strain. In previous experiments § when heterozygous mice (CFW strain) were employed, 52 out of 55 autografts (94%) and none out of 124 homografts grew successfully. Thus, if the strains of mice used in this experiment are homozygous, the proportion of successful transplants should be closely similar to the results obtained with the autografts. As can be seen in Table 1, a significant proportion of grafts among the CBA (77%) and C (74%) strains resulted in successful growth. Although the number of C_{57} mice used is small, all of these homografts remained viable. Surprising results were obtained in this experiment in that all of the successful grafts grew white hair. It should be remembered that C mice grow white hair, CBA mice brown hair, and C_{57} mice black hair. However, when skin was homografted within any of these strains the viable graft always grew white hair (Figs. 1 and 2).

TABLE 1.—*Transplantation of Single Skin Homografts Within the Same Inbred Strains of Mice*

Donor and Recipient Strain	Hair Color of Donor and Recipient	Grafts, No.	Viable Grafts, No.	Hair Color of Viable Grafts
CBA	Brown	22	17	White
C	White	27	20	White
C_{57}	Black	8	8	White

Experiment 2.—In this experiment the donors and recipients of the skin grafts belonged to different strains. The results in Table 2 clearly demonstrate the following: (1) C_3H mice support the growth of CBA skin; (2) CBA and C_{57} mice support the

§ References 5, 6, 7, and 8.

TABLE 2.—*Transplantation of Single Skin Homografts Within the Same Inbred Strains of Mice*

Donor Strain	Hair Color of Donor	Recipient Strain	Hair Color of Recipient	Grafts, No.	Viable Grafts, No.	Hair Color of Viable Graft
CBA	Brown	C3H	Brown	11	6	White
CBA	Brown	C	White	13	0	.....
C	White	CBA	Brown	30	22	White
C	White	C57	Black	13	9	White
C57	Black	C	White	12	0	.....

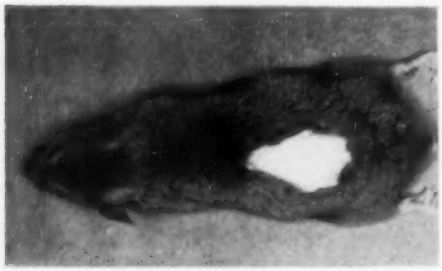

Fig. 1.—Skin from a CBA donor grafted on a CBA recipient.

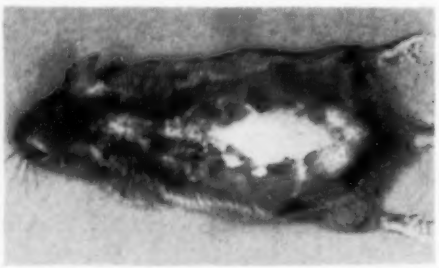

Fig. 4.—Shaved CBA mouse with a skin graft from a C donor.

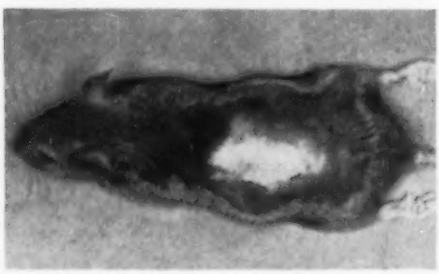

Fig. 2.—Shaved CBA mouse with a skin graft from a CBA donor.

Fig. 5.—Skin from a C3H parent grafted on a (C3H x C) F1 recipient.

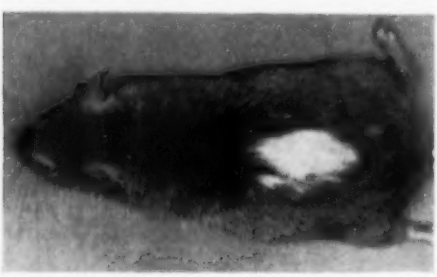

Fig. 3.—Skin from a C donor grafted on a CBA recipient.

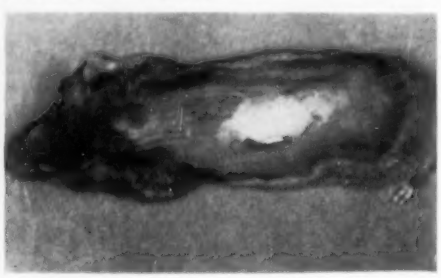

Fig. 6.—Shaved (C3H x C) F1 mouse with a skin graft from a C3H donor.

TABLE 3.—*Transplantation of Single Skin Homografts Among Parents and Offsprings of Crossbred Strains of Mice*

Donors	Hair Color of the Donor	Recipients	Hair Color of Recipients	Grafts, No.	Viable Grafts, No.	Hair Color of Viable Grafts
C	White	(C3HxC) F1 hybrids	Brown	11	11	White
C3H	Brown	(C3HxC) F1 hybrids	Brown	6	6	White
(C3HxC) F1 hybrids	Brown	C3H	Brown	6	5	White
(C3HxC) F1 hybrids	Brown	C	White	9	0	.....

growth of C skin, and (3) C mice do not support the growth of CBA or C_{57} skin.

The results indicate a close genetic relationship between CBA and C_3H mice and that hair color is an important factor in the successful transfer of skin between white and dark-colored strains of mice. Again, as in the previous experiment, all of the surviving grafts produced white hair (Figs. 3 and 4).

Experiment 3.—Two inbred strains of mice were crossbred to obtain donors as well as recipients from both F_1 (first generation) hybrids and the parent strains. C_3H (brown) and C (white) strains were employed. This mating resulted in brown-coated F_1 hybrids. In this experiment the data (Table 3) are comparable to the results in Experiment 2 in that skin grafts from brown-coated mice grew white hair (Figs. 5 and 6), and skin grafts from brown-coated mice failed to grow on white recipients.

COMMENT

Within the scope of these experiments it is shown that (1) it is possible to transplant successfully skin from one inbred strain to another; (2) whenever skin from brown-coated or black-coated mice was successfully transplanted, the grafts grew white hair, (3) skin from white mice grew in a majority of instances when transferred to brown- or black-coated mice; (4) skin from brown- or black-coated mice failed to grow on white mice, and (5) the transplantation of skin may be a simple and useful method for determining the relative homogeneity for strains of mice. These observations will be discussed in the above order.

A multiplicity of factors may influence the growth of skin grafts when the donors and recipients belong to different inbred strains of mice. Histocompatible genes may play an important role. The presence of similar or identical isoagglutinins may also be an influencing factor. Previous investigations ‖ clearly indicate that these possibilities are to be considered when studying the transplantability of malignant growths. Perhaps the presence or absence of the isoagglutinins are influenced by histocompatible genes. It may be possible that the growth of grafted skin depends on the inability of the graft to stimulate an "immune response" in the recipient.

The alteration of hair color in successfully transplanted skin grafts obtained from brown- or black-coated mice may be explained by the death or depression of the melanin-producing cells in the transplants. A sloughing of the epidermis in these transplanted skin grafts was a constant observation. This process probably removed the superficial pigment-producing cells. Histochemical studies to determine these pigment changes are in progress.

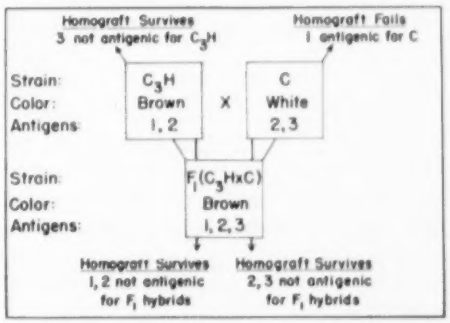

Fig. 7.—Schematic presentation of possible relationship between success or failure of homografted mouse skin and gene determination for hair color and antigenicity in inbred strains of mice.

There may be an important correlation between these findings in animals and those observed in humans. It is common clinical observation that autogenous skin grafts in human beings transferred from different body areas undergo unpredictable pigment changes. This color phenomenon is a great deterrent in the transfer of skin to cosmetic areas. Such an autogenous graft may assume a change of color varying from bleached white to pigmented brown. However, there are certain areas of human skin which can be selected for a fairly good color match: namely, the back of the ear and the lower neck. The transferred skin from any other area may result in a predictable color change.

The successful growth of white skin grafts on dark-coated mice and failure of dark skin

‖ References 4, 9, and 10.

grafts to grow on white-coated mice may be due to a concomitant gene determination for hair color and antigenicity (Fig. 7). Preliminary evidence for this is presented in the results of Experiment 3 (Table 3). In this experiment skin grafts from both parent strains grew successfully on the F_1 hybrids. It should be remembered that one parent strain, C_3H, is brown and the other, the C strain, is white. The dark color is dominant since all the F_1 hybrids were also brown. Skin from these hybrids grew successfully on the C_3H parent strain but not on the C parent strain.

From the above experiment it would seem that the transplantation of skin may become a useful method for the determination of homogeneity among inbred strains of mice.

SUMMARY

Skin homografts were transplanted on inbred strains of mice. A high percentage of successful transplants occurred when donors and recipients belonged to the same strain. Similar results were observed when a white donor strain was employed and the recipient strains were brown or black. However, when skin from black or brown mice was transplanted on the white mice none of the homografts survived. It was also observed that skin grafts from dark-coated mice always grew white hair when transplanted. Theoretical implications are discussed.

Wilford Hoofer, Marvin Liggett, and Betty Hopkins gave us technical assistance.

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Anomalous Pulmonary Arteries

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A diagnosis of anomalous pulmonary arteries is seldom made before surgery. Preoperative recognition of this condition is most important in cases of pulmonary disease requiring surgery of a lower lobe. The severance of such a vessel may result in exsanguination. In such a case we found the EPA (erect posterior-anterior roentgenogram) of the chest and the planogram to be of great aid in making the diagnosis.

Anomalous pulmonary arteries are frequently associated with another congenital defect, called intralobar sequestration of the lung. This latter condition consists of normal or polycystic lung substance within normal lung tissue. The abnormal pulmonary mass may have no bronchial drainage or may be supplied by a normal bronchial tree which is closed at the hilus; occasionally, the sequestrated lung tissue is associated with an abnormal bronchus which courses inferiorly towards the diaphragm. When the lung is involved in a pneumonic process, this sequestrated tissue similarly becomes involved and frequently remains infected when the surrounding tissue clears. Recurrent pneumonia, hemoptysis, or a lung mass seen on routine x-ray examination are the most frequent initial complaints which cause the patient to seek medical attention.

An anomalous pulmonary artery may supply normal or sequestrated lung tissue, or both. This artery is usually a branch of the lower thoracic or upper abdominal aorta and histologically differs from the more muscular bronchial arteries because of its larger amount of elastic tissue. Atherosclerotic changes in the vessel wall are frequent. The venous drainage of the sequestrated lung is nearly always by the normal pulmonary veins.

Most of the diagnostic means that have been advocated are directed towards the recognition of the dense sequestrated lung. The presence of a round or triangular mass in the lower lobe, a density having a finger-like projection directed downward and medially,[1] and a filling defect seen on bronchography have been described as aids in the recognition of these cases.

We would like to report two additional measures which are of aid in the recognition of this condition. Both means were beneficial in this case. First, on a routine EPA of the chest, the presence of long branching vertical lines (the anomalous arteries) directed towards the diaphragm should make one suspicious of an anomalous vessel (Fig. 1). Secondly, planography demonstrates both anomalous vessels in their entirety, beyond all shadow of a doubt (Fig. 2). To our knowledge, these methods have never been suggested as a means in the recognition of anomalous pulmonary vessels.

REPORT OF A CASE

A 26-year-old white woman was admitted to the medical service of Charity Hospital of Louisiana at New Orleans on Feb. 24, 1954, with a complaint of hemoptysis of ½ pt. (236 ml.) of bright red blood the preceding day. She gave no history of chills, fever, night sweats, pleuritic chest pain, weight loss, or exposure to tuberculosis.

At 3, 6, and 9 months of age she had pneumonia and since then had frequent upper respiratory infections. At intermittent intervals she had a cough which on occasions was productive of blood-streaked sputum. In July, 1949, and June, 1953, she was hospitalized at Charity Hospital for two serious episodes of hemoptysis.

In childhood, she was told that she had heart trouble. She has always complained of exertional dyspnea, orthopnea, palpitation, paroxysmal nocturnal dyspnea, intermittent cyanosis, and pulsation of her heart in the right side of the chest.

Familial history was significant in that two younger siblings died at ages 2 months and 2 years of "heart trouble."

On admission the patient was found to be a well-developed well-nourished young white woman not acutely ill and lying quietly in bed. The tempera-

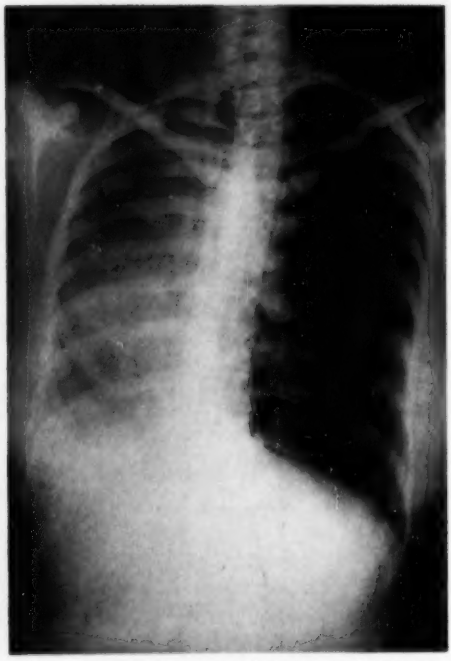

Fig. 1.—Roentgenogram of chest on admission.

ture was 98.6 F, respiratory rate 28, pulse 96, and blood pressure in the right arm 140/96 and in the left arm 130/94. The teeth contained many caries. There was deviation of the trachea to the right.

Fig. 2.—Anteroposterior planogram of chest cut 5 cm. from posterior chest wall.

Examination of the chest disclosed that the PMI was in the fourth right interspace 5 cm. from the midsternal line. There was a Grade IV harsh, blowing, holosystolic murmur audible best at the second and third interspaces just to the right of the sternum but heard over the whole precordium and transmitted well into the neck. The second sound at this position was loud and slightly prolonged. There was a holosystolic thrill palpable at the area of greatest intensity of the murmur. The breath sounds were slightly diminished over the upper third of the right hemithorax, greatly decreased over the middle third, and absent over the lower third. The lower one-third of the right hemithorax was dull to percussion. The left hemithorax was hyperresonant throughout and showed no area of cardiac dullness. There were coarse inspiratory rales scattered throughout the right hemithorax, especially in the base. Liver dullness was percussed on the right, and there was no evidence of enlargement. There were two vaginas, each containing a cervix. All the peripheral arteries showed normal pulsations, and there was no edema, cyanosis, or clubbing.

On admission, in July, 1949, essentially the same history and physical findings were recorded. Multiple views of the chest at that time showed deviation of the trachea to the right, haziness over the entire lower two-thirds of the right lung field, and the cardiac shadow on the right. Iodopyracet (Diodrast) studies of the heart demonstrated normal cardiac circulation with the heart markedly displaced to the right and an enlarged, elongated left pulmonary artery. The ECG showed a picture compatible with a vertical heart with counter-clockwise rotation around the longitudinal axis. The P waves in limb Lead I were upright. Bronchoscopy showed marked distortion of the bronchi and no evidence of endobronchial disease. Bronchograms revealed marked distortion of the bronchi of the right lung. The bronchus to the right upper lobe arose from the right main stem bronchus at an acute angle, but the smaller bronchial divisions to the upper lobe were not visualized. The bronchi to the right middle and lower lobes were convexed superiorly, with questionable cylindrical dilatation. The trachea and esophagus were deviated to the right. Cardiac fluoroscopy also revealed high right diaphragm, a normal-sized heart, and acquired dextrocardia. Arterial oxygen studies showed normal saturation values during exercise and rest while the patient was breathing air and oxygen. The patient was discharged with a diagnosis of long-standing postpneumonic atelectasis of the right lower lobe, with pleural adhesions and secondary dextrocardia.

On the second admission, in June, 1953, the history, physical findings, ECG, and x-rays were essentially the same, and she was discharged with the same diagnosis.

On this present admission the blood picture showed a hematocrit value of 46%, with 14.5 gm. of hemoglobin and WBC count of 13,850, with 67 polymorphonuclears, 3 basophiles, 2 monocytes, and 28 lymphocytes. Urinalysis was normal. The VDRL serological test for syphilis was negative. The blood chemistry studies showed a glucose of 114 mg. per 100 cc., CO_2 of 54 vols.%, BUN of 11 mg. per 100 cc., chlorides of 542 mg per 100 cc., and serum proteins of 6.16 gm. per 100 cc., with albumin-globulin ratio of 3.9:2.5. Sputum cultures showed alpha hemolytic Streptococcus, diphtheroids, and Micrococcus tetragenus. Cultures for acid-fast bacilli were negative. The Mantoux 1:10,000 test was positive at the end of 24 hours. ECG again showed a picture compatible with displacement of the heart to the right. Initial roentgenograms of the chest showed anomalous development of the first rib and scoliosis of the thoracic spine, with convexity to the right. The mediastinum was markedly displaced to the right. There was a diffuse haziness of the right lower lung field, but a broad longitudinal linear density was discernible in the middle portion; this structure showed several bifurcations as it curved superiorly just above the elevated diaphragm. The left lung was moderately emphysematous, and the stomach bubble was on the left. Bronchoscopy showed a right upper lobe orifice and two right lower orifices. In the left hemithorax there was an upper orifice, a middle orifice, and five lower orifices. Planograms of both lung fields showed a dense opacity, occupying the area of the right lower lobe, and an almost complete shift of the lower mediastinum to the right. The right lower lobe bronchus was displaced posteriorly. The middle lobe bronchus could not be definitely delineated. The upper lobe bronchus arose from the right main stem bronchus at an acute angle but appeared normal. There was a rudimentary right upper lobe pulmonary artery. The right lower lobe area was supplied by a tremendous arterial trunk which was thought probably to arise from the aorta below the diaphragm. In addition, there was a similar large arterial trunk supplying the left lower lobe area from below the level of the hilum. The left bronchial tree and pulmonary artery appeared to be normal.

The patient responded well to sedation and bed rest and had no severe hemoptysis while hospitalized for three weeks. For the first 10 days she continued to cough up white phlegm, which intermittently contained streaks of bright red blood; she then became asymptomatic. The patient was afebrile during her entire hospital stay. After the nature of her illness was discovered, it was carefully explained to her that aortograms, repeat bronchograms, and bronchospirometry would be of value prior to a right pneumonectomy, but she refused to consent to further diagnostic or therapeutic procedures. The patient was discharged on March 16, 1954. One month later, the patient was again seen in the outpatient department because of signs and symptoms suggestive of a right lower lobe pneumonitis.

COMMENT

There is little doubt about this right lower lobe structure being arterial in origin, although venous catherization and aortograms were not performed (Pryce and his coworkers [2] comment on only one case in which there was a venous drainage into the inferior vena cava; all others had a normal pulmonary venous return). Although the patient was studied by venous angiocardiography in 1949, the technique used at that time was such that revisualization of the lung, owing to its dual blood supply, would not have been discernible.

We are not definitely able to make a diagnosis of intralobar sequestration of the lung in this case because marked pleuritis and acquired dextrocardia so obscure the right lower lung fields that definite delineation of intrapulmonary masses are impossible. However, the history of recurrent pneumonia and hemoptysis in a person with multiple congenital defects, an associated ectopic pulmonary artery, and a bronchogram showing displacement of the right middle and lower lobes superiorly bespeaks strongly of an associated intralobar sequestration in the right lower lobe; however, the possibility of bronchiectasis can not be completely ruled out.

SUMMARY

A case of anomalous pulmonary arteries supplying the right and left lower lobes, with a probable associated intralobar sequestration of the right lung is reported.

Two additional roentgenological aids are described as being beneficial in the preoperative diagnosis of this condition.

Charity Hospital of Louisiana (12).

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Cystic Disease of the Breast

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Cystic disease of the breast is such a common entity, especially in the decade preceding the menopause, that one wonders whether this is an expected process. The main consideration has always been its relationship to carcinoma of the breast.[1] In 1940, Shields Warren [2] stated, "The breast cancer attack rate for women with chronic mastitis and related lesions in the age group of from 30 to 49 years is 11.7 times the rate for the Massachusetts female population; in the group over 50 years of age, 2.5 times as great; in the entire group 4.5 times as great."

Others have taken a more conservative view. At Memorial Hospital in New York, they are conservative; so are Haagensen, Campbell,[3] and others.

As a rule, most of the simple cysts and those showing only mild epithelial hyperplasia of one kind or another are handled conservatively, that is, by simple excision. The most troublesome situation arises when a varying amount of epithelial hyperplasia is present. Here the mode of therapy is often quite different. The pendulum swings from conservative simple excision to more radical simple mastectomy, and even bilateral simple mastectomy. Usually the pathologist shares the responsibility of this decision with the surgeon.

Much of the literature on benign breast lesions deals with the different entities separately. Frequently several of these individual lesions occur in the same breast.

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It has been shown in experimental animals that the various changes in cystic disease from simple cysts to cysts with intraductal hyperplasia and to carcinoma formation can be produced by massive doses of estrogens. This pattern is suspected, but not definitely proved, in humans. Similarly the mouse type carcinoma of the breast, probably caused by a virus as demonstrated by Bittner, has no distinct counterpart in humans.

Cystic disease of the breast includes several different morphologic lesions ranging from simple cysts with no epithelial hyperplasia to various hyperplastic states including lobular hyperplasia, sclerosing adenosis, intraductal papillomatosis, and intraductal hyperplasia.

We are interested, therefore, in determining whether the presence of any one of these different morphologic entities, separately or in combination with others, is of any significance in regard to recurrence of their lesions or to carcinoma.

This study is based on 289 cases of cystic disease in which operation was performed by Davis from 1938 to 1953. The clinical records and microscopic slides are reviewed. The histopathological findings are recorded from an objective viewpoint. The nomenclature is the same as that used by Foote and Stewart [4] in 1945.

The study is of special interest because most of the patients were treated conservatively. Local excision, namely, removal of the lump with only a small amount of breast tissue about it, was done in 266, or 92%. Of these, results are known in 201. With unilateral local excision, no further surgery was needed in 83%. With local excision done bilaterally, the results were good in 75%.

Simple mastectomy, unilateral or bilateral, was done in 23 patients, or 8%. These were mainly patients whose breasts were riddled

with cysts. Some mastectomies were done at the insistence of the pathologist because of the degree of epithelial hyperplasia. However, many with marked epithelial hyperplasia were treated by local excision only.

In only 4 of the 215 cases in which the results are known did carcinoma subsequently develop. This compares fairly well with the risk of carcinoma developing in women in general. Two of these patients are known to be well; one is lost to follow-up, and only one is known to have died of carcinoma of the breast.

In cystic disease, dilated mammary ducts are frequently found; they usually contain inspissated secretion, which may be white, gray, green, brown, etc. The secretion varies in consistency from liquid to sticky to pasty. Occasionally this may be expressed from the nipple when pressure is made over the ducts. Irritation by the secretion in dilated ducts often produces a periductal round cell infiltration.

An extremely frequent change in cystic disease of the breast is blunt-duct adenosis. Foote and Stewart so designate a change in

TABLE 1.—*Cystic Disease of the Breast*

	Total	Known Results	No Recurrence	Recurrence		Carcinoma
				Same	Opposite	
Unilateral local excision	251	189	158	20	9	2
Bilateral local excision	15	12	9	2	0	1
Unilateral simple mastectomy	19	12	9	0	2	1
Bilateral simple mastectomy	4	2	2	0	0	0
Total	289	215	178	22	11	4

TABLE 2.—*Sclerosing Adenosis*

Grade	Total	Known Results	No Recurrence	Recurrence		Carcinoma	
				Same	Opposite	Same	Opposite
1+	22	19	16	3	0	0	0
2+	21	16	10	4	1	0	1
3+	8	6	5	1	0	0	0
4+	6	3	3	0	0	0	0
Total	57	44	34	8	1	0	1

Bloodgood described so-called "blue-domed cysts" and stated that they did not tend to become carcinoma. In our tabulation we have divided them into those visible to the naked eye, which were larger than a low-power field of the microscope, and into small cysts that were smaller than a low-power field. Those of eosin-staining so-called apocrine type of epithelium are recorded separately. These overlap as many breasts contain two or all of these types. This type theoretically would be quite safe as far as the development of carcinoma is concerned.

Apocrine epithelium consists of very large, usually tall cylindrical cells that have relatively small nuclei and abundant clear, bright, eosinophilic cytoplasm. It was a very frequent finding in our cases and did not seem to be important prognostically.

which the ducts end abruptly and do not terminate in lobules. They stated, "Blunt end ducts usually originate at the distal or near distal extremities of the duct system, and since they begin at a point where periductal myoid tissue is absent or markedly attenuated, they typically lack this myoid investment and have a relatively poorly developed wall. . . . They are apt to end in a cluster of closely but irregularly spaced blind channels but with no resemblance to usual lobule formation. . . . The blunt end ducts furthermore often have relatively wide lumina which are actually wider by far than the mammary ducts from which they sprouted." The epithelium may be orderly or may be hyperplastic. There may be apocrine type of epithelium. These authors suggest that cyst formation may be the end-result of blunt-

duct adenosis. Approximately four-fifths of their patients had no further trouble, and 1 of 81 (Mrs. R.) developed carcinoma.

Sclerosing adenosis is a specific lesion commonly misinterpreted and erroneously diagnosed as carcinoma. It occurs in two forms: In the first a palpable tumor mass is present; in the second, minute focal areas are seen only on microscopic examination. The latter is much more common. Foote and Stewart consider it to be the result of abortive fibrosis or hyalinosis. The epithelium has lost the initiative and is choked by fibrous or hyaline matrix. Thin epithelial columns are haphazardly isolated and yield the impression of pleomorphism plus invasiveness. The nucleus stains regularly and mitosis is absent. In one patient carcinoma developed in the opposite breast. About four-fifths of patients remained well.

Hyperplasia of epithelium may occur as a single papilloma with a connective-tissue stalk, as a diffuse papillomatosis, or as a piling-up of epithelium within the duct. These changes may occur alone or more commonly may be associated with other types of lesions described in cystic disease of the breast. All degrees of hyperplasia may be found, and theoretically breasts with epithelial hyperplasia are the most likely to develop carcinoma. Many pathologists and surgeons advise simple mastectomy, either unilateral or bilateral, for these lesions.

A single papilloma with a connective-tissue stalk is not a common lesion, and the number of cases is too small for one to draw conclusions. There was no further trouble in any of the eight cases in which the results are known.

A more diffuse duct papillomatosis is much more common, and many consider this lesion precancerous. The surprising fact comes out that in more than four-fifths of these cases, no further cysts developed. One of 51 patients developed carcinoma. Of all 69 patients with duct papillomatosis, 56 had only a unilateral local excision, and 6 a bilateral local excision. In only four patients were unilateral simple mastectomies done. One of them had a previous carcinoma of the breast and later developed cystic disease of the opposite breast, for which one of us (H. H. D.) did a simple mastectomy. A bilateral simple mastectomy was performed as the primary operation in three. Of the seven who were reoperated on for recurrent cystic disease, a local excision was done in two; a unilateral simple mastectomy in three, and a bilateral simple mastectomy in two. Of the group of 62 treated by unilateral (56) or bilateral (6) local excision, only 1 developed carcinoma.

TABLE 3.—*Diffuse Duct Papillomatosis*

Grade	Total	Known Results	No Recurrence	Recurrence		Carcinoma	
				Same	Opposite	Same	Opposite
1+	23	19	17	0	1	1	0
2+	30	21	17	2	2	0	0
3+	12	8	6	1	1	0	0
4+	4	3	3	0	0	0	0
Total	69	51	43	3	4	1	0

TABLE 4.—*Epithelial Hyperplasia*

Grade	Total	Known Results	No Recurrence	Recurrence		Carcinoma	
				Same	Opposite	Same	Opposite
1+	5	3	3	0	0	0	0
2+	5	3	2	0	1	0	0
3+	8	6	3	1	1	1	0
4+	9	8	7	0	1	0	0
Total	27	20	15	1	3	1	0

The last group to be discussed is theoretically the most dangerous type, intraductal epithelial hyperplasia. In many of these cases it is extremely difficult to differentiate intraductal epithelial hyperplasia from noninvasive intraductal carcinoma. Pathologists disagree as to which lesions are called benign intraductal hyperplasia and which carcinoma. In spite of the fact that local excision only was the procedure in two-thirds of the cases, 75% had no further trouble. One patient with Grade 3 hyperplasia who had a local excision in 1946 developed recurrent bilateral cysts the following year, and bilateral simple mastectomy was done. On the side of her first operation later biopsy sections showed what was diagnosed as comedocarcinoma. The patient is well at the present time.

There were nine patients who had all three main types of duct hyperplasia, that is, papillomatosis, apocrine type of epithelium with papillomatosis, and epithelial hyperplasia. In the eight cases in which we know the results, there were no recurrences in six, but two of them were within the last two years. Recurrent cysts were found in the opposite breast in two. None developed carcinoma.

Table 5 shows the number of cases that have not developed recurrent cysts.

TABLE 5.—*Results of Treatment in Cystic Disease*

Pathologic Type	Known Results	No Recurrence	
		No.	%
Large hypoplastic cysts	133	111	83
Small hypoplastic cysts	150	128	80
Apocrine epithelium	84	72	85
Apocrine hypoplastic cysts	57	47	82
Stasis in ducts	112	86	76
Periductal mastitis	85	74	87
Blunt-duct adenosis	82	66	80
Sclerosing adenosis	44	34	77
Duct papilloma	8	8	100
Duct papillomatosis	51	43	84
Apocrine papillomatosis	34	29	85
Epithelial hyperplasia	20	15	75
Total patients	215	178	82

Many of the 215 patients had several types of lesions, which makes determination of exact factors in results impossible. It is surprising how little the type of lesion influenced the results.

CONCLUSIONS

A study of the results in cystic disease of the breast has been made in 215 patients. The lesions have been divided microscopically into pathologic types, there being many in this disease. The results in each type have been studied. The results are informative in that 92% of the patients were treated by unilateral or bilateral local excision, and only 8% had simple mastectomy. No further procedures have been necessary in 82%; recurrent cysts were reoperated on in 16%, and carcinoma has developed in 1.86%. Surprisingly in the 113 patients with hyperplasia of the duct epithelium, 84% have had no further trouble.

It is realized that a longer period of follow-up would be more informative. It is planned to continue this study in the future.

Trends are indicated, but it is realized that the number of patients is much too small to be statistically significant. It is hoped that similar studies, breaking the cases down into the pathologic subdivisions, will be made in some of the institutions having large numbers of such patients.

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Surgical Approach to Postmastectomy Lymphedematous Extremity

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Many papers have been written dealing with the problem of the lymphedematous extremity. This approach may be a partial answer to this annoying problem. It is hoped that other surgeons will give this permanent thoracic tubed pedicle approach a fair trial, as it is fully realized that this single case report does not adequately prove the point.

CASE REPORT AND TECHNIQUE

The patient, aged 66, was first seen at the Milwaukee County General Hospital in October, 1951. She had a removal of the right breast for carcinoma in March, 1934, followed by a series of six x-ray treatments to the right chest and axillary area. She stated that since these treatments she had persistent swelling of the entire right arm, with discomfort and limitation of motion. In July, 1951, she developed an ulceration in the right anterior axillary area.

Warm saline compresses were used in an attempt to clean up and heal the ulceration. It was soon found that conservative therapy would not be sufficient, as the ulceration was deep and there was a considerable amount of scar tissue within the base of the ulcer. It was also noted that the entire right chest and right axillary area was covered with a scarred telangiectatic type of skin owing to the x-ray therapy.

A biopsy specimen was taken of the ulcer area in order to rule out carcinoma, and this was found to consist of scar tissue and chronic inflammation. Unfortunately, no preoperative photograph was obtained.

The therapy decided upon was the use of a thoracic tube pedicle. This would provide skin and fat coverage for the ulcerated area and, at the same time, increase the circulation to the right axillary area. It was hoped that this would also reduce the edema of the right arm.

She was taken to surgery on Jan. 31, 1952, and two transverse incisions were made on the right lateral thoracic wall approximately 10 in. (25 cm.) in length and 3½ in. (8.8 cm.) apart. The areas of skin and subcutaneous tissue between the two incisions were undermined. The edges of the skin incisions were brought together with interrupted nonabsorbable black surgical (silk) sutures, forming the tube pedicle. After wide undermining, closure of the skin underneath the tube pedicle was accomplished directly.

The tube healed uneventfully. Three weeks after elevation of the tube, string-tie delay of the tube was done on the posterior end. This trained the circulation into the tube from the anterior end. A tie was placed for 15 minutes the first day and this time was increased to 2 hours by the fifth day.

The posterior end of the tube pedicle was then freed, on Feb. 28, 1952. The skin edges on the chest were approximated, after undermining, with interrupted black nonabsorbable (cotton) surgical sutures.

The area of the x-ray ulcer in the right axilla was excised. The ulceration extended down to the

Figure 1.

axillary vessels. All bleeders were tied off with 000 plain absorbable (gut) sutures. The posterior detached end of the pedicle was then brought into the axillary area and sutured to the edges of the excised area with interrupted 000 black (silk) sutures. Pressure dressings were applied with lateral pads placed to protect the tube pedicle. A body cast was applied to hold the arm in abduction so that circulation of the pedicle was not impaired during its healing period. The fact that the arm was held in a position above the level of the heart throughout the healing period may account for the partial initial rapid reduction of the edema of the arm.

The surgical wound healed uneventfully, except for a small persistent sinus in the upper end of the pedicle, which the patient was able to care for adequately herself, with satisfactory results. The persistent sinus was undoubtedly due to the fact that the ulceration extended so deeply into the axilla that all of the scar tissue could not possibly have been cleaned out. This sinus finally healed after three months of gauze wick dressings impregnated with bacitracin.

COMMENT

Adequate coverage of skin and fat in the axilla was provided by this method. Three months after application of the pedicle, it was noted that the skin surrounding the area in which the pedicle was attached became softened and whitened out. The telangiectasia in this location disappeared, evidently owing to the fact that there was a considerable increase of circulation. At the same time, it was noted that there was a gradual reduction of the edema of the right arm until it became normal size. The pain and cramps in the right arm disappeared. The function of the arm was improved. The patient's general condition and outlook on life improved considerably.

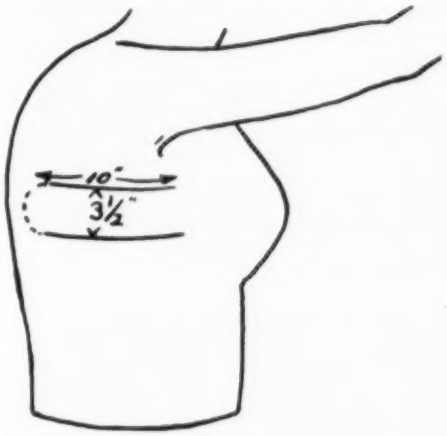
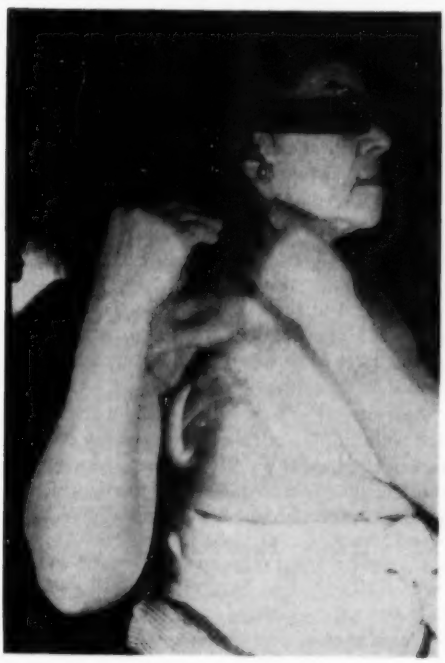


Fig. 3.—Diagram showing location of pedicle incision. The posterior end of the pedicle was detached and moved into the anterior right axilla.

Figure 2.



The tube is not in the patient's way, and I believe that it increases the circulation to the axillary area and to the arm to the extent that there is a better circulatory flow and a better venous and lymph return.

CONCLUSION

This case report presents a method of using a thoracic tubed pedicle of skin and fat as a permanent blood-carrying vehicle. This is an approach to the postmastectomy lymphedema problem. The reader's comments, views, and trial of this procedure will be appreciated.

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Primary Jejunal Ulcer with Recurrence Following Resection

Report of a Case

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The term primary jejunal ulcer has been given to a group of cases in which a chronic circumscribed ulcer has been demonstrated in the jejunum. Morphologically, these lesions resemble peptic ulcer of the duodenum and they are of unknown etiology. There are some 50 authenticated instances recorded of the disease in the jejunum. Evert [1] analyzed 130 cases of small intestinal solitary ulcers in 1948. This review included examples of nonspecific ulcers in both jejunum and ileum as the same disease. Other authors* hold the view that the entity in the upper jejunum is separate and distinct from the commoner ileal ulceration, where known specific break-downs of aggregate lymph patches occur.

The case presented here is an unusual primary jejunal ulcer, discovered at operation, located close to the ligament of Treitz, and recurrent after resection on two occasions. Recorded instances of reoperation on these lesions are unusual; one has been reported.[4] However, the return of symptoms following resection has been observed,† and the majority of case reports do not include follow-up after early convalescence. This patient was followed throughout her course, and recurrent lesions plus autopsy specimens were available for this study.

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* References 2 and 3.

† References 3 and 5.

REPORT OF CASE

History.—A 53-year-old white woman was admitted to University Hospitals of Cleveland on Feb. 5, 1950, with moderate intermittent abdominal distress for 10 years. She was well until 1940, when a series of sudden attacks of upper abdominal crampy pain began. The pain frequently required morphine for relief, but it was abated by aluminum hydroxide gel (Amphogel) daily. One year later the attacks recurred. They were now accompanied by intermittent generalized swelling of the abdomen, epigastric spasm, and diarrhea. In 1944 she noticed tarry stools. There were several episodes of fainting, and blood hemoglobin was 50% of normal. In 1945 and 1946 the patient had extensive x-ray and laboratory studies. A gastrointestinal series and barium enema were reported as negative, but gastric analysis showed "high acid." Three years before admission the pain alternated between a continuous epigastric ache and cramps in the left upper quadrant. Food and warm milk would occasionally relieve the epigastric distress. She had been dubbed psychoneurotic by several physicians. Two weeks prior to entry the patient became bedridden with weakness, dark stools, and increasing pain.

Past History.—No previous serious disease.

Family History.—The family history was noncontributory.

Physical Examination.—The positive findings were limited to slight tenderness in the left upper quadrant extending into the epigastrium. There was no mass and no spasm, and bowel sounds were normal.

Laboratory Findings.—Hemoglobin was 11.2 gm. and WBC 8700; urine examination was normal; fasting blood sugar was 75 mg., and serum amylase was 26 units. Total serum protein was 5.3 gm. (albumin 3.3 gm. and globulin 2.0 gm.). The BUN was 12.0 mg. Occult blood in feces was 3+, and fasting gastric suction specimen showed 68 units of free HCl.

X-Ray Studies.—Chest plate, barium enema, and cholecystograms were normal. The G. I. series

showed thickened mucosal folds in the stomach. Evacuation at the pylorus was rapid, and the duodenum was dilated and abnormally smooth. The upper jejunum had coarse mucosal folds with some segmentation of barium on the motility studies. (Examination of films after surgery showed retention of barium in an ulcer niche just beyond the ligament of Treitz.)

Operation.—The long-standing history of distress and duodenal ileus prompted surgery. The abdomen was entered through a left rectus incision, and the lesion was found in the first portion of jejunum. Approximately 7 in. (17 cm.) from the ligament of Treitz, the bowel was kinked and adherent to its own mesentery. The latter structure was slightly thickened and indurated in the region of contact with the looped bowel. The short proximal jejunal segment as well as the entire duodenum was moderately dilated, and the walls of these structures were slightly thickened. When the jejunal loop was freed from contact with mesentery, an ulcer 2 cm. in diameter was found. It was located on the antimesenteric border, approximately 15 cm. from the ligament of Treitz. The ulcer had penetrated the jejunal wall and its flat base was adherent to the mesentery. The lesion had the gross characteristics of a peptic ulcer, and there was no evidence of tumor. The intestine was divided approximately 8 cm. distal to the lesion, and an end-to-end anastomosis was carried out after the proximal division was made at the ligament of Treitz. The terminal duodenum was also freed from its fibrous attachments to facilitate the anastomosis.

Subsequent Course.—After the first operation there was a brief temperature spike to 39.4 C (102.9 F). Gastric suction averaged 2000 cc. per day, however; liquids were taken on the fifth day with a rapid return of normal intestinal function. The wound healed well, and the patient was asymptomatic on discharge. Three weeks later she was readmitted to University Hospitals because of vomiting and crampy upper abdominal pain. This episode responded well to Levin tube gastric suction and atropine. After five hospital days she was again discharged symptom-free. Gastric analysis before discharge showed 50.6 units of free HCl in the fasting specimen.

Ten months after this episode, she entered another hospital, with upper abdominal crampy pain, vomiting, hematemesis, and melena. Examination disclosed a tender mass just above the umbilicus. The WBC was 17,500; Hgb. was 58% of normal; stool was positive for occult blood, and a gastric analysis showed 46 units of free HCl. A high jejunal obstruction was demonstrated by x-ray. After multiple transfusions and antibiotics the patient was operated on, and a jejunocolic fistula was found. Portions of jejunum and colon were resected and end-to-end anastomoses rejoined jejunum to jejunum and colon to colon.

The last hospital admission was on May 9, 1951, approximately three months after the second operation. The patient had lost 20 lb. (9.1 kg.) during this time, and she had suddenly become semicomatose after a brief period of vomiting. The abdomen was markedly distended, and there was generalized tenderness. She died after one day in the hospital, despite intensive intravenous therapy and antibiotics.

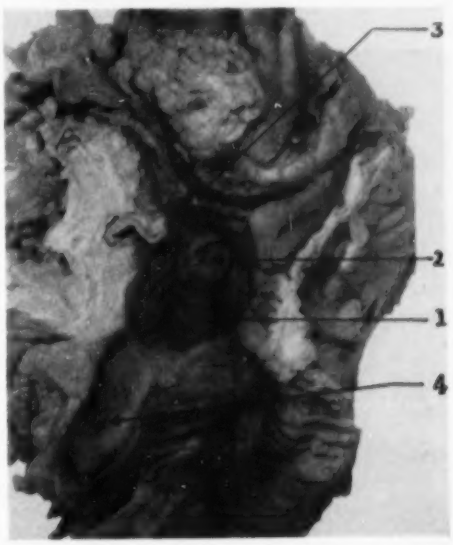

Fig. 1.—Photograph of gross autopsy specimen showing the opened jejunum: (1) large recurrent jejunal ulcer; (2) fistulous communication with mucosa of transverse colon in upper portion; (3) thrombus in branch of adjacent mesenteric artery; (4) adjacent localized ulcer with flat base.

Pathology.—The segment of jejunum removed at the first operation showed a rounded ulcer 2 cm. in diameter on the antimesenteric border. The edges were slightly raised and well demarcated. Microscopically (Fig. 1), the mucosal continuity was interrupted by an ulcer with a superficial dense inflammatory exudate containing polymorphonuclear leucocytes and fibrin. Adjacent to and beneath this layer, there was a zone of dense collagenous connective tissue. In the margins of this connective tissue there were arteries showing proliferative arteritis. The adjacent mucosa and submucosa showed edema and infiltration with scattered round cells. Many lymphocytes and a few plasma cells were present. In the adjoining intestinal mucosa Paneth cells were evident. Several areas close to the ulcer showed deep tubular glands with occa-

sional branching. These glands were lined by columnar epithelium and scattered goblet cells. Many epithelial cells were modified so that their shape was pyramidal. These cells contained distinct acidophilic cytoplasmic granules. There were occasional collections of acini beneath the muscularis mucosa containing compressed basal nuclei.

The surgical specimen from the second operation demonstrated a localized ulcer in the jejunum. This was 3×4 cm. in diameter, and there was a fistulous tract running from the ulcer base into the adjacent transverse colon. Microscopically, the ulcerated area showed a superficial necrotic zone over a zone of organizing granulation tissue. Lymph nodes in the adjacent mesentery were enlarged and showed nonspecific adenitis.

Fig. 2.—Photomicrograph of ulcer edge from the original resected lesion. Granulation tissue of ulcer base on the left and modified jejunal crypts with deep acini shown on the right.

Autopsy following the last hospital admission disclosed recurrent jejunal ulceration (Fig. 2). Two ulcers were present near the site of previous resection. One was oval, 4×1.5 cm. in diameter. The other was round and 3×2.5 cm. The ulcer base of the latter lesion once again communicated with the transverse colon. Adjacent to the fistulous tract the wall of the superior mesenteric artery was eroded. The vessel contained a thrombus, and a major portion of small intestine was infarcted.

COMMENT

The etiology of the lesion presented in this case is unknown, and this is an outstanding feature of the syndrome. However, the lesions have often been termed "peptic ulcers" because their morphology resembles that of the typical duodenal ulcer. Therefore, the action of digestive secretions plus some other local factor operating to decrease viability of mucosal cells has been mentioned in many previous discussions as a possible etiologic factor. Free acid was demonstrated in this patient on several occasions and evacuation at the pylorus was rapid as shown by a barium meal. An excessive quantity of gastric secretion was suggested by the large volume of Levin tube drainage. Intubation studies on small bowel [6] and terminal duodenum [7] have suggested that contents of these regions can have marked acidity when gastric acidity is high and evacuation at the pylorus rapid. These facts, along with the rapid recurrence of the ulcer at the site of resection, makes one suspect in this case that the corrosive action of gastric juice was a factor in producing the lesions.

All the ulcers described here conformed to the gross and microscopic picture of peptic ulcer of the duodenum. The original surgical specimen was sectioned from terminal duodenum to well beyond the lesion. Brunner's glands were identified near the ulcer and in the upper 10 cm. of jejunum, but no heterotopic pyloric glands were seen. Deep-branched jejunal glands adjacent to the lesion (Fig. 2) at first suggested ectopic gastric mucosa, but these structures adjacent to the mucosal defect were probably the result of metaplasia. These peculiar heterotopias have been described adjacent to regenerative processes in other chronic inflammatory lesions of bowel.[8]

Clinically, the disease is one to be ruled out when a bizarre gastrointestinal problem presents itself. It is also a lesion not to be overlooked when the surgeon is confronted with a generalized peritonitis and no obvious source of infection can be found. This oversight has been reported.‡

‡ References 2 and 9.

Careful x-ray studies should be the most useful adjunct to a diagnosis in these rare lesions. The first operation in this case was undertaken because of a moderate duodenal ileus. Examination of the gastrointestinal series after operation disclosed the ulcer niche. These findings have been previously demonstrated § in association with this disease.

Surgical therapy is made imperative by the high incidence of complications, namely, perforation, hemorrhage, and obstruction. In instances accompanied by generalized peritonitis, simple closure of the lesion is advocated. This has been done repeatedly with success, but the return of symptoms should prompt elective resection. In the elective case wide excision of the involved bowel with primary anastomosis has been done. Several successful cases accompanied by long term follow-up studies have been reported after this procedure, but the therapy proved inadequate in the present case. It is possible that further study will show a greater number of these cases to have high gastric acidity and increased volume of secretion. Vagotomy and/or gastric resection may be indicated along with local resection of the lesion.

§ References 3, 9, and 10.

Dr. Charles Chesner, Pathologist, and other physicians at St. Joseph Hospital, Lorain, Ohio, helped in the preparation of the report of this case.

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Follicular Lymphoblastoma of Stomach with Ulceration Simulating Gastric Ulcer

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Lymphosarcoma of the stomach is not a common neoplasm and in the great majority of cases is not diagnosed before operation. According to Ewing, lymphosarcoma of the stomach constitutes about 1% of malignant gastric lesions.

The number of reported cases of lymphosarcoma simulating gastric ulcer is small. Cabot, in 1933, reported two cases. One case was incorrectly diagnosed clinically as gastric ulcer and carcinoma of the stomach, while the second case was correctly diagnosed as lymphoblastoma of the stomach with ulceration.

Koucky, Beck, and Atlas reported a case of acute perforation of a lymphosarcomatous ulcer of the stomach which was diagnosed by biopsy at the time of operation.

Pack and McNeer emphasize the point that patients with lymphosarcoma of the stomach not infrequently present a typical ulcer pain history with x-ray studies showing an ulcer. Perforation of ulcerating lymphosarcoma is more frequent than in carcinoma, according to these writers. In their opinion, gastric lymphosarcoma is extremely radiosensitive and responds favorably to combined surgical and radiation therapy.

The following case is considered worthy of report, not only because of the general principles which it exemplifies in diagnosis and management of gastric lymphosarcoma but because of the fact that in this case the lymphosarcoma was of a special variety, so-called follicular lymphoblastoma.

REPORT OF A CASE

A white man, P. R., aged 56, was admitted to the Middlesex General Hospital on Sept. 14, 1950, with chief complaint of recurrent epigastric pains. He had been in good health until Nov. 4, 1947, when he developed epigastric pain one-half to one hour after meals, relieved by sodium bicarbonate and milk. Under an ambulatory Sippy diet and antacid powder therapy he improved. At no time did he have nausea or vomiting, and he never noted any change in the color of his stools. His weight remained stationary at 160 lb. (72.6 kg.). X-rays of the G. I. tract taken Nov. 10, 1947, showed no evidence of ulcer or malignant disease. The following comment was made by the roentgenologist: "The hypertrophic state of the gastric mucosa, especially in the antral portion, is disturbing. The suspicion of possible malignant changes exists." The patient continued to feel well, and on May 5, 1949, another x-ray was taken and no evidence of malignant ulcer was reported. On Sept. 8, 1949, the patient suffered a severe attack of substernal pain, radiating down the left arm. A diagnosis of coronary occlusion was made, and he was hospitalized for seven weeks. An electrocardiogram revealed acute coronary occlusion with infarction of the anterior wall. Because he had no gastric symptoms, the patient now stopped all ulcer therapy. Ten months later (Aug. 8, 1950), he again complained of severe epigastric pains, unrelieved by antacid therapy and methantheline (Banthine). No nausea, vomiting, or tarry stools had been noted. Gastrointestinal x-rays were again taken (Aug. 24, 1950), and a large peptic ulcer was found in the lower midportion of the posterior wall near the lesser curvature of the stomach. In view of the long recurrent history of epigastric pain (three years) and the x-ray finding of gastric ulcer, surgical treatment was advised. On Sept. 14, 1950, he was admitted to the Middlesex General Hospital.

Physical examination revealed a normally developed man who weighed 160 lb. (72.6 kg.) and did not appear ill. His blood pressure was 100/70. Acute tenderness was noted in the midepigastrium, but there were no other abnormal findings in the abdomen. Rectal examination revealed a slightly enlarged prostate gland. The diagnosis on admission was penetrating gastric ulcer.

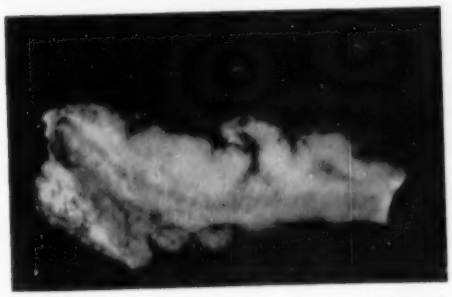


Fig. 1.—Sagittal section through wall of stomach at site of tumor (natural size).

Laboratory data revealed R. B. C. 5,100,000 (hemoglobin 15.7 gm.) and W. B. C. 9,800, with normal differential count. The Mazzini test was negative. Total serum protein was 6.6 gm. per 100 cc. The urine was normal. Gastric analysis revealed free acid up to 57 units and total acidity up to 87 units. Electrocardiogram revealed evidence of old anterior wall infarction.

After suitable preparation he was subjected to operation on Dec. 18, 1950. The stomach was found to be involved in the lower midthird of the posterior wall near the lesser curvature by an ulcer surrounded by a small firm mass of tissue. Several enlarged regional lymph nodes were found, but there were no visible peritoneal or liver metastases. A high subtotal gastrectomy, removing approximately 75% of the stomach, was carried out with anterior Polya type gastroenterostomy.

Surgical Pathological Report: Resected stomach 12 × 11 cm., exhibiting near its lower portion a marked thickening of the mucosa. A large irregular deeply scooped-out ulceration is present, measuring 2.5 × 3 cm. Cut section through this area reveals an infiltration of whitish tumor extending considerably beyond the ulcer margins, occupying and replacing the mucosa as a homogenous, dense, white infiltration. The tumor tissue is of varying thickness and extends through all layers in the region of the ulcer. The regional nodes are moderately enlarged and partly or completely replaced by a similar whitish infiltration.

Microscopic Report: The infiltration is of round cell character and extends through all layers and separates the muscle bundles into small units or replaces them completely. The infiltration extends into the adjacent mucosa and undermines the latter, causing much thickening of the mucosal and submucosal tissues. The larger part of the infiltration consists of cells of lymphoblastic nature in varying stages of maturation, including formation of enormous germinal follicles with an outer margin of compressed mature cells. Sections through the lymph nodes show extensive replacement by similar infiltration with a large number of follicles of varying size, often very large, and a relatively small amount of mature lymphoid tissue.

The diagnosis was follicular lymphoblastoma with secondary ulceration and involvement of regional lymph nodes.

The patient had an uneventful postoperative course and left the hospital seven days after operation in good condition. Postoperative radiation therapy was begun three weeks after operation. He was given seven treatments of 1050 r over regional gastric nodes. One month after operation he returned to his occupation. A blood cell count performed six months after operation showed R. B. C. 4,000,000; hemoglobin 77% (10.7 gm.), and W. B. C. 8,150. He continued to work until Aug. 23, 1953, when he was admitted because of difficulty in urination. At this time he stated that during the past six months he had frequency, nocturia, and pain, burning, and hesitance on urination with the passage of some blood. Examination revealed a hard irregular prostate, suggestive of carcinoma.

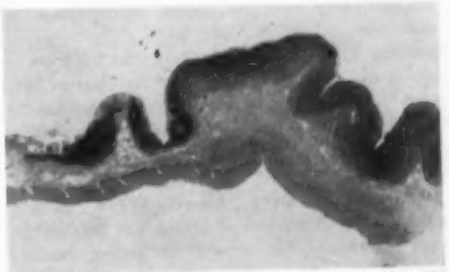
On Aug. 25, 1953, a transurethral resection was performed. The tissue, when cut, seemed much harder than the usual carcinoma of the prostate. Microscopically, it was revealed as an infiltrating lymphoblastic cell tumor showing a tendency to folliculoid differentiation, consistent with follicular lymphoblastoma.

On Oct. 20, 1953, the patient was readmitted complaining of weakness and loss of more than 30 lb. (13.6 kg.) in the past two months. The patient had much x-ray therapy to the lymph nodes of the neck, chest, abdomen, and prostate. An x-ray of the chest was reported to show enlargement of the hilar nodes and a mottled confluent infiltration in the left lung base. A G. I. series recently performed showed a normally functioning stoma and no abnormal findings. The patient was thin, emaciated, dyspneic, and weak.

On Oct. 21, 1953, a lymph node removed from the axilla showed follicular lymphoblastoma.

On Oct. 23, 1953, x-ray of the chest revealed the mediastinal shadow to be definitely increased in

Fig. 2.—Photomicrograph (low-power), showing mucosal infiltration.



density. The patient continued a downhill course and died on Oct. 28, 1953.

Significant Autopsy Findings.—Kidneys: The right kidney exhibited on section intense inflammation, thickening, and reddening of the entire calyceal and pelvic mucosa. A whitish tumor nodule the size of a large pea, projected upon the surface anteriorly, and another nodule, of somewhat larger size, on the posterior surface, showed on section a wedge outline resembling an anemic infarct. The bladder was contracted and filled with considerable mushy yellowish-white putty-like material with calcareous granules. When removed, the mucosa showed wide plaques of whitish calcareous incrustation. On section it showed much whitish tissue resembling tumor extending downward posteriorly to the prostate, which was similarly altered, embedded, and fused with the bladder thickening.

G. I. Tract: The stomach had been partly resected and a well-formed anterior gastrojejunostomy was present with a well-functioning stoma.

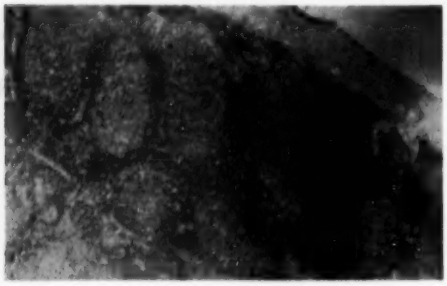


Fig. 3.—Photomicrograph (higher-power), showing follicular differentiation with lymphoma.

The site of anastomosis was intact. Immediately above the lesser omentum was a mass of conglomerate nodules of tumor, almost the size of the closed fist. The mass on section showed whitish soft homogeneous tumor and was covered with intact serosa. It projected slightly into the mucosa of the stomach but did not enter the lumen. It was not associated with ulceration or recent hemorrhage.

Microscopic Observations.—Sections of lymph nodes showed almost total replacement of the original parenchyma by diffuse accumulation of large cells of lymphoblast type. Only a vague tendency to a folliculoid structure was apparent in most nodes examined. Microscopic sections of lung tissue revealed wide areas of solid infiltration by tumor, causing obliteration and virtually complete extinction of the preexisting parenchyma and framework.

Perigastric Tumor (Recurrence): Section showed solid infiltration of serosa and fat. In the most advanced edge of the infiltration, marked anaplasia was observed in the form of enormous giant nuclei and irregular contours. Mitoses here were very abundant and often peculiar and bizarre.

COMMENT

In the case described, the clinical history yields few clues to the diagnosis. X-rays of the stomach, while suggestive, added little information to warrant radical treatment until a large ulceration had developed. Although the antral mucosa had been reported to show hypertrophic rugae of suspicious nature, the findings were not so marked as in the case reported by O'Donoghue and Jacobs, in which the giant rugae were observed. As in many of the cases described by other writers, the patient's early symptoms were typical of benign ulcer even to the extent of relief by diet and antacids. The capricious nature of the illness in this case, in contrast to the more nearly continuous pattern of evolution of gastric carcinoma, is borne out further by the longer period of freedom from symptoms, totaling perhaps three years or longer, before the final burst of activity, in which a well defined ulcer could be demonstrated for the first time.

One additional feature of this patient's clinical course may be worthy of comment. One year prior to operation he had an attack of coronary arterial occlusion with an electrocardiographic pattern of anterior wall infarction. Nevertheless, the patient tolerated the operation in a completely satisfactory manner and sustained no evident after-effect. It is clear that a history of coronary arterial disease need be no deterrent to radical life-saving surgery when due regard is held for the patient's general condition.

The histological diagnosis in this case was "follicular lymphoblastoma." Long periods may elapse before the malignant nature of the disease becomes apparent. In the earlier phases of its evolution the disease manifests itself in sporadic appearance of rapidly enlarging masses in one or another location in the body. In the late stages a change in structure toward greater anaplasia usually occurs, and the terminal course is generally that of reticulum cell sarcoma of polymorphous cell sarcoma.

CONCLUSIONS

Lymphosarcoma of the stomach, while rare, should not be overlooked among diagnostic possibilities in a patient presenting typical or atypical features of the peptic ulcer syndrome.

The roentgenologic features may at times be suggestive or distinctive of the disease, but in many instances they are indistinguishable from those of benign ulcer or ulcerated carcinoma.

A case of follicular lymphoblastoma of the stomach is reported, which is of much interest in showing in all its typical features the picture of follicular lymphoblastoma from its earliest development, as a focal bulky isolated tumor of a particular region, to its final culmination, as a highly malignant infiltrating tumor of many regions including the lungs, bladder, prostate, and lymph nodes.

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Utilization of Glucose, Fructose, and Invert Sugar

Comparison in Diseases of the Liver and Pancreas

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Although numerous reports dealing with the comparative utilization of infused glucose, fructose, and invert sugar have appeared in the recent surgical and biochemical literature, the results of these studies are still equivocal. Certain investigations have indicated that fructose and invert sugar are superior to glucose for parenteral feeding purposes; others have suggested the reverse.

In previous studies Weichselbaum,[1] Elman and Lund, using infusion rates of 0.6 to 2 gm. per kilogram per hour, reported that after fructose the urine contained little sugar as compared with glucose. The diuretic effect was less pronounced with fructose. Lawton and Curreri and Gale found that a 10% solution of invert sugar can be given more rapidly and is more completely utilized than glucose.[2] They also noted a lessened diuretic effect with invert sugar. In this study 1 liter of solution was infused at a rate of 1.5 gm. per kilogram body weight per hour for only 30 minutes; it was found that more fructose than glucose was excreted both in normal persons and in patients with liver disease.[3] J. L. Smith and co-workers concluded that invert sugar and fructose are not as well utilized as glucose when given at a rate of 1 liter of 10% solution in two hours' time.[4] Finally, M. Miller and his associates found that similar amounts (less than 10%) of glucose and fructose appear in the urine after infusions of these sugars at the rate of 1 gm. per kilogram per hour.[5]

Such apparently contradictory reports can be partially resolved if one appreciates the fact that the experimental conditions under which these various studies were carried out varied considerably with respect to rate, duration, and amount of infusion, as well as to the state of nutrition and hydration of the patients. Moreover, in very few studies did the patient act as his own control.

Therefore, the present study was undertaken in an effort to determine whether fructose and invert sugar had a significantly greater clinical value than glucose in the parenteral feeding of various types of hospital patients. Included in the study were patients with pancreatic and liver disease as well as those patients whom we classified as normal. The latter group was comprised of patients with minor nonmetabolic diseases.

Our interest in studying pancreatic disease was based on the observation that the phosphorylation of fructose appears to be less influenced by insulin than the phosphorylation of glucose.* In view of the occasional diabetic state seen in certain types of pancreatic disease, we became interested in determining whether or not fructose might be the sugar of choice in such disorders.

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* References 5 and 11.

The rationale of studying patients with liver disease was derived from the experimental data which showed that fructose is more readily phosphorylated than glucose [8] and also that fructose was a better source of liver glucose.[9] An additional consideration was the loss of glucose tolerance observed in patients with hepatic disease.

In addition to the infusion studies the comparative hepatic glycogenic properties of these hexoses were studied in dogs and in humans. While the precise role of hepatic glycogen in protecting the liver against injury is not clear, adequate glycogen storage would seem to be a desirable condition. This investigation represents an attempt to determine which sugar has the greatest ability to form such glycogen.

METHODS OF INVESTIGATION

Each patient served as his own control in that comparable infusions of glucose and fructose or glucose and invert sugar, or all three, were performed in each case. The interval between infusions was usually 48 hours. In patients with hepatitis and subsiding acute pancreatitis the infusions were carried out on successive days. The order of the tests was alternated from case to case.

Patient Groups: (1) The so-called normal cases consisted of 10 patients with miscellaneous minor, nonmetabolic disease, all in the preoperative state. All patients known to be diabetic or patients with a family history of diabetes were excluded. (2) In the pancreatitis series, the state of the disease varied from the subsiding acute stage to the chronic recurrent stage. In the former group we elected to defer our studies until the acute stage of the disease had subsided since such patients were not in equilibrium with respect to their state of hydration and nutrition. Therefore, these patients were not studied until two or three days from the time of admission and the serum amylase had returned to normal or near-normal levels. It must be assumed, however, that the inflammatory changes in the pancreas itself had not completely subsided. A total of eight fructose-glucose studies and five invert sugar-glucose studies were conducted. (3) In the liver disease groups the study included patients with both cirrhosis and hepatitis. Cirrhotics with ascites were excluded because a considerable amount of the infused sugar solution was observed to collect in the ascitic fluid. A total of seven fructose-glucose studies and five invert sugar-glucose studies were carried out in patients with hepatitis. In cirrhosis seven fructose-glucose and six glucose-invert sugar studies were completed

Preparation of Patients: All patients fasted 12 hours prior to the study. A series of liver function studies was made in all patients. Physical activity was restricted during the test period. Five cubic centimeters of a mixture of the B vitamins (Sol-U-B) was administered intravenously or intramuscularly on the day prior to the study in an effort to minimize the effects of a subclinical vitamin B deficiency on carbohydrate metabolism.

Infusion Technique: All sugars were in 10% solutions in water and were infused at the rate of 37 gm. per square meter per hour. This rate of infusion was based upon the administration of a gram per kilogram per hour in a patient of average height and weight. The employment of surface area in calculating the dose of sugar permitted an infusion more consistent with actively metabolizing tissue mass than does weight alone. Specifically, this technique minimized the error of an overdose in the obese subject and of an underdose in the thin subject.

All infusion bottles were weighed before and after infusion to enable accurate measurement of the administered sugar. We have observed as much as a 100 cc. variation in the amount of solution contained in a so-called 1 liter bottle. Had this weighing procedure been omitted, an unrecognized error as great as 10% in intake might have been introduced in some cases. The infusions were administered at a constant rate by a drop count measurement. Samples of venous blood for glucose, fructose, serum inorganic phosphorus, and lactic acid were drawn from the opposite arm at 0, 45, 90, 150, and 210 minutes from the start of the infusion. Urine

specimens for glucose, fructose, sodium, and potassium and total volume determinations were collected at zero, one and one-half, two and one-half, three and one-half, four and one-half, and six and one-half hours from the start of infusion.

All subjects in the normal group were on the standard hospital diet for at least 24 hours prior to the studies. Their prehospitalization diets were judged to be nutritionally adequate. The dietary intake of subjects in the pancreatic and liver disease groups varied considerably, but a comparable nutritive state was obtained prior to the two infusions administered to each patient.

The infusion period was arbitrarily set at 90 minutes in order that approximately 1000 cc. of solution (or slightly greater or lesser amounts, depending upon the individual's surface area) could be administered, thus simulating an actual clinical infusion.

A major portion of the study was devoted to the investigation of the comparative glycogenic properties of glucose, fructose, and invert sugar in an entirely different group of human subjects as well as dogs. The quantitative determination of hepatic glycogen was made by formal liver biopsy prior to and after the infusion of glucose, fructose, invert sugar, or saline. All sugar solutions were of a 10% concentration in distilled water. Three human and two animal controls received saline alone.

Patients undergoing elective upper abdominal operations (i. e., gastrectomy or cholecystectomy) were used for the human studies. Anesthesia consisted of sodium pentothal, cyclopropane, and oxygen, with frequent supplementation by nitrous oxide. Ether was used only rarely. An initial biopsy specimen was taken upon entering the peritoneal cavity; afterward an infusion of one of the previously mentioned sugars or saline was started. The infusion was allowed to run at an uncontrolled rate until near the end of the surgical procedure when the second biopsy specimen was taken.

The plan of study was similar in dogs except that the anesthesia was induced by intravenous administration of pentobarbital (Nembutal), and the sugars were infused at the rate of 1 gm. per kilogram for a two-hour period. A total of 16 were infused. Two control animals received saline alone during the two-hour infusion period.

Biochemical methods were as follows: glucose determination was made by the dinitrosalicylic acid method; fructose, by the pyrogallic acid method; lactic acid, by the parahydroxyphenyl method; inorganic phosphorus, by the Shinowara modification of the Bodansky method, and sodium and potassium, by flame photometry.

RESULTS AND COMMENT

The relatively rapid rate of infusion employed in this study was selected inasmuch as a great portion of the work done on this subject has been based on similar or even more rapid rates of infusion.† In actual clinical practice it would seem advisable to give such solutions at a slower rate in view of the possibility of overloading the circulatory system, particularly in elderly patients. This complication was not observed in our series. A further disadvantage of rapid infusions can be seen in the occasional patient in whom the diuresis exceeded the infused volume, regardless of the sugar employed. In such instances there was an increased loss of electrolytes as well as body water.

It was noteworthy that two apparently healthy patients were excluded from the study when they developed typical diabetic blood sugar curves after the second infusion. The tolerance curves with the first infusion had been normal. These changes occurred after infusion of glucose in one instance and of fructose in the other. Fortunately, the fasting blood sugar eventually returned to normal levels in one case, although it proved necessary to discharge the second patient on small doses of insulin. These two cases illustrate how readily a patient with little or no islet reserves can be converted into a frank diabetic state by placing unusually great demands on the remaining islet cell tissue. Such islet cell decompensation probably

† References 1, 2, 5, 6, and 7.

TABLE 1.—*Composite Data from All Groups*

Subject Group	Cases, No.	Solution	Duration (Min.)	Rate* (Gm Sq. M./Hr.)	Infused Volume (Cc.)	Blood Determinations: Fasting T. R. S.† (Mg. %)	Maximum Rise T. R. S.‡ (Mg. %)	Maximum Rise Fructose‡ (Mg. %)	T. R. S. 2 Hr. Post-Inf. (Mg. %)	Fructose 2 Hr. Post-Inf. (Mg. %)	Maximum Incr. Lactic Acid‡ (Mg. %)	Maximum Decr. Inorgan. Phos.‡ (Mg. %)	Urine Determinations: Total Sugar Loss (Gm.)	Sugar Loss, %	Water Loss (Cc.)	Na Loss (mEq.)	K Loss (mEq.)
Normal.....	10	G	91.7	36.18	993.2	101.2	452.5	....	64.8	....	12.44	1.57	10.6 ± 3.41§	10.8	828	45.63	13.22
		F	90.0	37.18	1007	95.7	258.7	79.8	78.4	4.1	36.65	1.06	5.4 ± 2.31	5.4	704	52.49	17.64
	10	G	89.6	37.34	979	99	438.7	....	65.1	....	14.75	1.55	11.2 ± 5.57	11.5	786	34.76	10.88
		IS	90.7	36.81	978.5	98.4	320.4	42.5	78.5	5	22.10	1.54	5.2 ± 1.91	6.4	839	38.93	10.39
Pancreatitis.....	8	G	92.5	36.1	935	96	457.3	....	115.2	....	11.80	1.42	11.9 ± 6.16	13.8	725	.....	.....
		F	91.7	36.9	950	101	272.3	80.8	130	10.7	32.40	1.03	6.3 ± 2.07	7.2	677	.....	.....
	5	G	90.8	36.5	851	95.6	510	....	138	....	16.87	1.00	11.3 ± 4.38	13.4	801	.....	.....
		IS	91.6	37.1	873	106	420	49	116.4	1.5	32.37	1.06	6.4 ± 3.84	6.9	578	.....	.....
Hepatitis.....	7	G	89.42	36.7	1007	101.4	547	....	176.4	....	15.90	2.76	18.5 ± 7.25	18.1	897	.....	.....
		F	90.1	37.0	1028	95.7	323.5	112.4	112.4	11.9	33.70	0.66	9.7 ± 3.95	9.2	604	.....	.....
	5	G	87.8	37.4	968	106	528.7	....	215	....	19.00	3.23	17.0 ± 10.66	16.4	705	.....	.....
		IS	90.6	37.3	989	108	438.7	50	168	10.9	23.50	1.60	7.8 ± 2.72	7.6	681	.....	.....
Cirrhosis.....	7	G	89.4	38.8	988	89	526.7	....	125.8	....	7.00	0.92	8.3 ± 4.91	8.7	684	.....	.....
		F	90.8	38.4	988	84.4	330.5	137.3	143.8	17.5	31.70	1.25	8.9 ± 3.31	9.0	655	.....	.....
	6	G	89.4	39.1	972	78.7	532.3	....	91.2	....	3.90	1.23	8.3 ± 4.82	8.7	684	.....	.....
		IS	91	38.4	965	82.5	444	51.8	60.0	8	8.20	1.27	5.8 ± 2.42	6.2	868	.....	.....

* Surface area was calculated from Metropolitan Life Insurance height-weight tables and the Dubois Surface Area Chart.
† Total reducing substances.
‡ From fasting level.
§ Standard deviation.

occurs more commonly than is recognized and might well be kept in mind before one decides to flood an organism with intravenous carbohydrates. This would apply particularly to glucose but includes fructose since a considerable portion of this sugar may be converted to glucose.

In all groups studied the increase in blood total reducing substances was greatest with glucose infusions, less with invert sugar, and least with fructose (Table 1). The blood glucose levels rose moderately during fructose infusions, presumably as the result of conversion of fructose to glucose. Postinfusional hypoglycemia was more common with glucose than with fructose or invert sugar.

In general, the serum lactic acid reached a much higher peak in all groups studied during the fructose and invert sugar infusions than the glucose infusions (Table 1). The increase in circulating lactic acid doses not necessarily signify increased oxidation of carbohydrate as it may also represent a decrease in the liver's ability to convert lactic acid to glycogen. That the high lactic acid peak with fructose and invert sugar may not signify increased oxidation was suggested by those cases in which the sugar loss with these solutions exceeded that with glucose in spite of the chracteristic high lactic acid peak after the administration of fructose and invert sugar. In any event, conclusive evidence that the increase in blood lactic acid signifies increased oxidation is lacking.

Serum inorganic phosphorous fell in all groups during the infusion period regardless of the type of carbohydrate infused (Table 1). No characteristic pattern was apparent with respect to disease entity.

In the so-called normal patients the loss of sugar in the urine was twice as great with glucose as with fructose (Table 1). This increased glycosuria with glucose was accompanied by an increased diuretic effect amounting to an average of 124 cc. over that for fructose. On the basis of an average infusion of approximately 100 gm. of sugar, the differences were slight since the greater loss with glucose represented only an additional 5 gm. of carbohydrate, an amount which represents approximately 20 calories. It would be difficult to attach any clinical significance to the saving of such a small number of calories. The 124 cc. of increased diuresis with glucose may also not be of significance considering the usual individual variations in state of hydration.

As indicated in Table 1 there was a slightly greater urinary loss of electrolytes of sodium and potassium associated with the fructose infusions. The increased electrolyte loss with fructose amounted to approximately 7 mEq. with respect to sodium and approximately 4 mEq. with respect to potassium. This difference was clinically unimportant.

The results of the studies which compare glucose and invert sugar were similar to those for glucose and fructose, with the exception that the diuretic effect was slightly greater with invert sugar, amounting to approximately 53 cc. (Table 1). In addition, there was no difference in the potassium loss with these two sugars.

Patients with pancreatic disease also lost about twice as much sugar with glucose as with fructose or invert sugar (Table 1). The diuretic effect was also less pronounced with fructose and invert sugar. Here, also, the difference between glucose and either fructose or invert sugar amounted to less than 30 calories per infusion and would, therefore, appear to be of little clinical significance under the conditions of these observations. The average diuretic effects were 48 and 223 cc. less with fructose and invert sugar, respectively, as compared to glucose diuresis. No differences were noted between patients with chronic recurrent pancreatitis and those with subsiding acute pancreatitis. Several known pancreatic diabetics, not included in our data, spilled considerably greater amounts of glucose than fructose.

Patients with hepatitis exhibited a loss of tolerance for all three hexoses, particularly glucose. In this group, the fructose and invert sugar losses were 9 gm. less than the loss with glucose (Table 1). In several cases the glucose loss exceeded the sugar loss with fructose by much greater amounts. Three

patients with hepatitis developed a mild hypoglycemic syndrome after glucose infusions but not after fructose infusions. This occurrence can probably be explained by the fact that the hepatic glycogen reserves of the organism are depleted in hepatitis and thus are unable to furnish the increased glucose required as a result of the increased insulin activity elicited by the glucose infusions. Again the diuretic effect was less marked with fructose and invert sugar than with glucose. This difference amounted to 293 and 24 cc. per infusion for fructose and invert sugar, respectively.

In cirrhosis, in contrast to the previous findings, the average loss after fructose infusion was slightly larger than 0.6 gm. (Table 1). The failure of the cirrhotic patient to utilize fructose better than glucose as noted all other groups might be attributed to the fact that a considerable portion of the infused fructose is normally utilized by the liver, a function which perhaps is impaired in cirrhosis but not in hepatitis. This reversal of trend was not present with the comparison of invert sugar with glucose in which the glucose loss exceeded that for invert sugar by 3%. Glucose diuresis was 29 cc. more in the fructose series and 184 cc. less in the invert sugar series.

It will be noted in Table 1 that the standard deviation for glucose, fructose, and invert sugar excretion was rather large in all patient groups. This would suggest that the observed differences in sugar excretion are not statistically significant.

With respect to the hepatic glycogen studies in humans, no definite conclusions can be drawn owing to the many variables involved in the conduct of the studies (Table 2). Both rises and falls in liver glycogen were observed with the use of glucose, fructose, or invert sugar without any definite trend. These studies show, however, that by the use of any of the various hexoses the depletion of hepatic glycogen resulting from anesthesia and surgery can be prevented in some cases and presumably minimized in other cases.

TABLE 2.—*Hepatic Glycogen Data in Humans*

Solution	Case No.	Increase in Hepatic Glycogen Over Fasting Levels, %	Decrease in Hepatic Glycogen Over Fasting Levels, %
Saline	1	.....	0.485
	2	.....	0.739
	3	.....	0.08
Glucose	1	0.649	.....
	2	0.073	.....
	3	0.141	.....
	4	1.48	.....
	5	.....	0.21
	6	.....	0.265
	7	.....	0.945
	8	.....	2.165
	9	.....	0.33
	10	.....	0.821
Fructose	1	1.22	.....
	2	0.64	.....
	3	0.29	.....
	4	0.476	.....
	5	1.171	.....
	6	1.161	.....
	7	.....	0.356
	8	.....	1.510
	9	.....	2.263
	10	.....	2.095
	11	.....	0.831
	12	.....	0.569
	13	.....	1.088
	14	.....	2.726
Invert sugar	1	0.848	.....
	2	0.460	.....
	3	0.610	.....
	4	.....	3.047
	5	.....	0.460
	6	.....	0.505
	7	.....	0.560
	8	.....	0.725

TABLE 3.—*Hepatic Glycogen Data in Dogs*

Solution	Animal	Increase in Hepatic Glycogen Over Fasting Levels, %	Decrease in Hepatic Glycogen Over Fasting Levels, %
Saline	1	.....	3.52
	2	.....	0.156
Glucose	1	1.235	.....
	2	0.360	.....
	3	0.385	.....
	4	1.119	.....
	5	1.253	.....
	6	2.23	.....
	Ave.	1.097	.....
Fructose	1	0.894	.....
	2	1.04	.....
	3	2.547	.....
	4	3.519	.....
	5	2.714	.....
	6	2.44	.....
	7	2.270	.....
	Ave.	2.209	.....
Invert sugar	1	1.986	.....
	2	2.34	.....
	3	1.024	.....
	Ave.	1.783	.....

In the animal studies hepatic glycogen levels rose in all cases, using either fructose, glucose, or invert sugar (Table 3). The increase was greatest with fructose, exceeding that with glucose by twofold. The increase with invert sugar was intermediate with respect to glucose and fructose.

In all cases in which saline alone was employed (three human studies and two dog studies), hepatic glycogen fell. These data illustrate the well-known fact that liver glycogen stores are reduced under the stress of general anesthesia and surgery.

These findings are consistent with the work of Cori, who showed in rats given sugar orally that fructose formed liver glycogen in greater amounts than glucose.[9] This information may be profitably applied to patients with depleted liver glycogen from a variety of causes including primary liver disease in which such stores are characteristically reduced. Liver glycogen serves the purpose of meeting the immediate call for glucose by the tissues throughout the body whenever such a need should arise. Muscle glycogen, in contrast, is primarily for local use.[12] Sufficient liver glycogen would decrease the work load of the liver by decreasing the need for gluconeogenesis. The protein stores of the organism would also be protected by virtue of the protein-sparing action of carbohydrate.[10] Thus in conditions characterized by parenchymal liver damage carbohydrate would serve indirectly to favor hepatic regeneration. Ravdin has shown that increasing liver glycogen in experimental animals serves to protect such animals against fat-soluble hepatotoxins by virtue of the decrease in the lipid content of the liver cells.[10] Adequate liver glycogen would aid in the process of detoxication of many toxic agents including anesthetic and sedative drugs by providing an adequate supply of glucose for such purposes.

CONCLUSIONS

Comparative infusions of 10% glucose, fructose, and invert sugar at an average rate of 1 gm. per kilogram body weight per hour were given to three groups of resting patients, each patient serving as his own control for two and, occasionally, three of the sugars used. Blood sugar, lactic acid, and inorganic phosphorus levels and urinary losses of sugar, sodium, and potassium were measured for a period of six and one-half hours beginning with the infusion.

Infusions of fructose and invert sugar led to smaller losses of urinary sugar than glucose in normal subjects and patients with pancreatic disease and hepatitis. However, the difference did not exceed 9 gm. per infusion in any of the three groups studied.

In general, the diuretic effect was slightly less marked with fructose and invert sugar.

In normal subjects the loss of sodium was slightly more pronounced with fructose and invert sugar than with glucose. Potassium losses were a little greater after fructose but not after invert sugar infusions.

Serum lactic acid levels were consistently higher with fructose and invert sugar than with glucose in nearly all patients, including those cases in which the urinary loss of sugar with fructose and invert sugar was greater than with glucose.

Serum inorganic phosphorus fell in nearly all patients without a definite pattern, with respect to type of sugar infused or patient group.

Symptomatic postinfusional hypoglycemia was observed with glucose but not with fructose or invert sugar in three patients with hepatitis.

In patients undergoing major surgical procedures under general anesthesia a fall in hepatic glycogen was always observed with infusions of saline. This fall in hepatic glycogen could be prevented in many patients by infusion of any of the three hexoses studied.

Fructose (followed by invert sugar and glucose in this order of decreasing effectiveness) has the greatest ability to form hepatic glycogen in dogs under pentobarbital (Nembutal) anesthesia. This observation suggests that fructose may be the most useful sugar in patients with depleted hepatic glycogen reserves.

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Sliding Hernia of Diverticulum of Bladder

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Ordinary bladder hernia is a fairly common condition, and many articles have been written about it. A recent and excellent one is that by Kollberg.[1] Iason [2] concludes from various statistical studies that the over-all incidence of bladder hernia is between 1% and 3%. In his own personal cases,[3] however, he found the incidence to be 10% in men more than 50 years of age. Erdman,[4] in a study of 8600 cases from the literature, found the incidence to be 4 per 1000.

Sliding hernia of the bladder is also fairly common, both in direct inguinal hernias and in femoral hernias.[5] This paper, however, deals with sliding hernia of a diverticulum of the bladder. While I have encountered no description of this condition in the textbooks, it is probably not as rare a condition as one would judge from a perusal of the literature.

REPORT OF CASES

Case 1.—F. O. H., a white 59-year-old man, was first seen by me on March 30, 1949. He had moderate-sized bilateral inguinal hernias, slightly larger on the right than on the left.

On April 12, 1949, the patient was operated upon at the Church Home and Hospital under spinal and thiopental (Pentothal) sodium anesthesia. A right inguinal incision was made. When the canal was opened, it was found that the hernia was of the saddle-bag type. The indirect sac was opened and the direct sac converted into an indirect sac by the Hoguet [6] maneuver. In freeing the sac, a large mass of fatty tissue was encountered in the defect in the transversalis fascia. In attempting to dissect this from the sac by blunt dissection with a piece of gauze, urine was encountered. No bladder muscle and nothing to indicate the presence of the bladder had been seen. It was found that we were dealing with a diverticulum of the bladder consisting only of bladder mucosa, which formed a part of the wall of the sac. This was dissected free and the opening in the bladder closed with continuous No. 00 plain absorbable surgical (gut) sutures, reinforced with interrupted sutures of the same material. The hernia repair was then completed by Halsted's original method.[7] I had considered doing a repair of Cooper's ligament but abandoned the idea owing to the accident of opening the bladder. For the same reason, it was decided not to operate on the left side at the same sitting. A retention cathether was placed in the bladder.

After the operation the patient told me that he had noticed that when his bladder was full the hernia on the right side was larger and caused him more trouble than it ordinarily did. The catheter was removed seven days after the operation, and the next day the patient's temperature went up to 104 F. but immediately came down to normal again. This was the only reaction he had to the presence of the indwelling catheter. He was discharged from the hospital on April 24.

On July 29, 1949, cystocopy was done by Dr. J. A. C. Colston, who found no infection in his bladder and no evidence of the diverticulum.

The patient was last seen on May 17, 1954, more than five years after his operation. The hernia site was firm, and he was having no trouble. He has consistently refused, however, to have the hernia on the left side repaired.

Case 2.—L. B., a 59-year-old white man, was first seen by me on Feb. 26, 1952. He had a small recurrent right inguinal hernia.

Operation was performed on Feb. 27, 1952, at the Union Memorial Hospital with the patient under thiopental (Pentothal) sodium, nitrous oxide, and cyclopropane anesthesia. A right inguinal incision was made and the canal opened. After the various structures were dissected free, it was found that the sac came directly through the conjoined tendon. The sac was opened. It was surrounded by a fibrous envelope containing some fat. In the attempt to dissect this free, a diverticulum of the bladder was encountered and entered, although the bladder was very much in my mind, remembering Case 1, of less than two years previously. The diverticulum formed a part of the wall of the sac and came directly through the conjoined tendon along with the sac. After disposal of the sac, the diverticulum of the bladder was obliterated and the opening in the bladder was closed with a running No. 00 plain absorbable surgical suture reinforced by interrupted su-

tures of the same material. The hernia repair was completed by the Halsted method. A Foley catheter was placed in the bladder.

The patient's convalescence was uneventful, except that he was greatly annoyed by cystitis, in spite of being kept on sufisoxazole (Gantrisin). As he was a surgical colleague, I asked a urologist, Dr. Howard C. Smith, to look after him so far as his bladder was concerned. Dr. Smith removed the catheter four days after operation. The patient continued, however, to have some trouble with cystitis for several days longer.

Being a surgical colleague, this patient is frequently seen, has a good result from his operation, and has had no further bladder diease.

COMMENT

The preoperative diagnosis of hernia of the bladder of any kind is seldom made.[1] A careful history might make one suspect the condition, and should have in the first case reported here. However, correct histories are hard to elicit. Kollberg found only four cases reported in which preoperative roentgenological examination helped the physician to arrive at the correct diagnosis. These were not cases of diverticulum of the bladder but simply hernia of the entire bladder wall. Hinman[8] suggests that cystography might be a good routine in all cases of inguinal hernia in men more than 50. Considering the thousands of men more than 50 who come to operation for hernias and the relatively small number of hernias of the bladder, and especially of hernias of a diverticulum of the bladder, such a routine procedure seems hardly justifiable.

Watson[9] believes that diverticula of the bladder are usually congenital when the neck of the sac is very narrow and the walls are thin. Both of the cases reported here fitted into that anatomical description. They were both finger-like projections from the bladder, the walls consisting only of mucosa, and the necks being narrow. The first case may have been congenital. That was a primary hernia without previous operation. However, I do not believe that the second case could be considered to fit into that category. The hernia was a recurrent hernia which came directly through the conjoined tendon and was of the direct type. I believe that the hernia sac in making its way through the conjoined tendon was probably attached to the wall of the bladder and pulled a part of the wall of the bladder along with it. Of course, this would presuppose a weakness in the wall of the bladder; otherwise the entire thickness of the bladder wall would have accompanied the hernia sac instead of just mucosa. So long as this is the case, one would possibly have to presuppose at least a congenital weakness in the bladder wall, or else some traumatic weakness occasioned by trauma at the first operation.

Almost every surgeon of experience has penetrated the bladder in operating for hernia. Whether this is justifiable or not is open to question. There are cases, however, in which the accident cannot be avoided, no matter how much care is exercised on the part of the surgeon. A resident of the late Dr. Dean Lewis once penetrated into the bladder and, in reporting the accident to his chief, said, "You know one isn't a surgeon until he has been in the bladder at least once during a hernia repair." Dr. Lewis replied: "Yes, but I didn't expect you to be a surgeon quite so soon." Ordinarily, it is very easy to avoid penetrating the bladder, even when operating for sliding vesical hernia. The bladder can usually be readily identified by the fat on its surface, the tortuous vesical veins, and the thickness of the bladder wall. These warning signs generally keep the surgeon well out of trouble in operating for hernia no matter how much the bladder is involved. However, when a diverticulum of the bladder forms part of the wall of the hernia sac and the wall of the diverticulum consists only of bladder mucosa, the matter is more difficult. Maybe here also the utmost in care would prevent entering the diverticulum. In the first case reported here, a diverticulum of the bladder was not even considered. In the second case, I had it constantly in mind and used extreme care in dissecting the hernia sac free, but even with the utmost care the diverticulum was entered. There was nothing in its external appearance to suggest its nature.

The very considerable inconvenience suffered by the second patient, due to cystitis caused by the indwelling catheter, makes me question the advisability of using an indwelling catheter in cases in which the bladder is inadvertently entered. Some urologists * do not believe that this is necessary. Experimental work of my own [10] some years ago would tend to bear this out. In these experiments large experimentally made holes in the bladder of dogs were closed with a piece of alcohol-preserved ox fascia lata. No catheters or any other method of relieving intravesical tension were used in these experimental animals; yet the wounds healed perfectly without leakage of urine. If catheters are not used in clinical cases, in suturing the bladder silk or cotton should be used in the outer suture line (in the bladder musculature), because either can be depended upon to remain in situ until firm healing occurs. Absorbable (gut) sutures should be used in suturing the bladder mucosa, as the use of nonabsorbable sutures there would cause stone formation.

SUMMARY

Two cases of sliding hernia of diverticulum of the bladder are reported. One was in a primary indirect hernia. The other was in a recurrent hernia, and the direct hernia sac and the diverticulum came through a small opening in the conjoined tendon. The wall of each diverticulum consisted only of bladder mucosa, which made it difficult; it was almost impossible to know that a diverticulum was being dealt with until it had been entered.

1014 St. Paul St. (2).

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Perforation of Small Intestine in a Newborn Infant

Review of the Literature and Report of a Case in a Premature Infant, with Recovery

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Perforation of a hollow viscus in the newborn infant has been reported by several observers.* The condition is unusual, and the diagnosis has undoubtedly been overlooked in many cases of deaths in newborn infants. The case being reported is one of spontaneous perforation of the small bowel in a newborn premature infant weighing 1310 gm. (46 oz.). Recovery followed recognition and prompt surgical repair of the perforation.

Only one previous recovery of a perforation of the small bowel in a newborn infant could be found in the literature.[2] Only one case of recovery following perforation of the large bowel has been reported in the literature.[6] Thirty-nine cases of bowel perforation, without recovery, were collected by Russell.[8] Most of these were large bowel perforations. Perforations of gastric and duodenal ulcers in newborn infants have also been reported.† Thelander[10] collected 46 such cases, with recovery in only 1 case.

In cases of perforation of a hollow viscus the diagnosis can be made in most cases, even though the exact site of perforation may not be known preoperatively. The usual picture is one in which the infant looks ill shortly after birth and takes food poorly. Vomiting is frequent, the vomitus containing bile. The child may have had a bowel movement of mucus or meconium. The infant is often cyanotic and has rapid labored respirations. The abdomen is distended and tympanitic. There may be edema of the abdominal wall, the flank, and the scrotum or vulva. The temperature may be subnormal. The hemoglobin and hematocrit levels may be high as a result of dehydration and shock.

A scout film of the abdomen will corroborate the clinical impression of a perforated abdominal viscus. An extensive pneumoperitoneum will be seen as will a diffuse distention of the bowel. Studies with barium or other contrast media are not particularly helpful and may be harmful. The use of such contrast media will certainly cause unnecessary delay and decrease the chance for survival. Even if an atresia is the cause for the perforation, x-ray with contrast media is not of practical value. The atresia will be discovered at the time of the laparotomy for the perforated viscus.

There are several causes for a bowel perforation in the newborn infant. The commonest cause is obstruction of the bowel, with perforation proximal to the site of obstruction. The obstruction may be due to a congenital atresia or to a condition known as "meconium ileus." In the latter condition, there is inspissation of meconium in the intestinal tract, apparently the result of impaired function of the pancreas, such as that which may occur in fibrocystic disease of the pancreas.[3] The pancreatic deficiency results in inadequate digestion of the meconium which, in its inspissated state, can produce

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* References 1, 2, 7, 8, and 10.

† References 10 and 11.

a complete obstruction. Other possible causes for obstruction are volvulus, congenital bands, and intussusception. These are undoubtedly extremely rare as a cause for bowel perforation in the neonatal period. Birth trauma has been considered as a cause for such a perforation. Thelander, however, did not consider trauma as a contributing factor, since the evidence supporting this idea is unconvincing.

It is my belief that one must also consider such possible causes as a perforation of a peptic ulcer at the site of heterotopic gastric glands in the wall of the small bowel and failure of proper development of the wall of the bowel at some particular point. The latter two conditions could account for some of the so-called "spontaneous perforations."

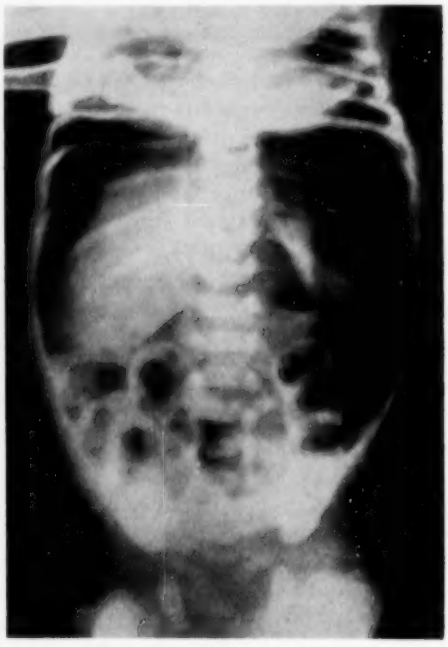
In the treatment of a perforated viscus the cause should be eliminated whenever possible. In those cases in which an obstruction is not demonstrable, the opening in the bowel should be closed by simple suture or, if necessary, by local resection. If an atresia is present, resection or a side-tracking operation should be performed. Meconium ileus had been described as uniformly fatal ‡ until a recent report by Hiatt and Wilson.[4] These observers believe that mere resection or side-tracking operations will not correct the underlying condition in meconium ileus. They suggest removal of the inspissated meconium by flushing the bowel with saline through an enterotomy and then instilling a solution of 5% pancreatin into the lumen of the bowel. The catheter used for the irrigation is then removed, and the opening in the bowel is closed by suture.

REPORT OF A CASE

E. D., a permature infant girl, was born at an outlying hospital on April 22, 1952. The birth weight was 1450 Gm. (51 oz.). The labor was described as an uneventful breech delivery. The infant's condition was described as "fair" at birth. She was transferred to Michael Reese Hospital in an incubator.

On April 23 and 24, the infant had a meconium bowel movement. On April 25, the infant vomited bile-stained material, and on April 26 the abdomen was distended and tympanitic. There was obliteration of the liver dullness on percussion and muscle spasm in the right upper quadrant of the abdomen. A scout film of the abdomen revealed a marked pneumoperitoneum and several dilated loops of small bowel (Fig.). The temperature was 98.6 F rectally.

Surgical consultation was requested on the afternoon of April 26, and an exploratory operation was advised. Preoperatively, the surgeon noted rigidity in the right upper quadrant. A catheter was passed into the stomach for continuous suction. A cannula was inserted into an ankle vein, and 40 cc. of plasma and 150 cc. of 5% dextrose in water were given intravenously before operation. The infant's weight on the morning of surgery was 1310 gm. (46 oz.).



Scout film of abdomen illustrating extensive pneumoperitoneum.

The infant was taken to the operating room in an incubator, where she remained until it was time for the skin preparation and draping. The preoperative diagnosis was a perforation of the gastrointestinal tract. The infant was surrounded by warm water bottles on the operating table. Anesthesia consisted of local infiltration of 0.25% procaine. Oxygen was administered by mask throughout the operation. A right upper rectus incision

‡ References 5 and 9.

was made. As the peritoneum was opened, there was heard the sound of escaping gas. A moderate amount of seropurulent drainage was noted within the abdomen, especially in the right upper quadrant. A knuckle of small bowel was found adherent to the under surface of the liver. When this loop of bowel was gently freed, it was noted that there was a 0.6 cm. perforation in the wall of the bowel. The wall of the bowel surrounding the perforation was necrotic for a distance of a few millimeters. The appearance of the bowel wall resembled that ordinarily seen in a perforated peptic ulcer of the stomach or duodenum. No tissue was taken for biopsy. The segment of bowel involved was identified as lower jejunum or upper ileum. No obstruction could be demonstrated distal to the site of perforation. There was moderate distention of the small bowel proximal to the site of perforation, but the distal bowel was collapsed. A mechanical obstruction had been secondarily produced by kinking of the small bowel after it had become adherent to the under surface of the liver. The perforation was sutured in two layers with interrupted 00000 nonabsorbable surgical (silk) sutures on an atraumatic needle. The abdominal wall was closed by through-and-through 00 silk sutures. Cultures of the exudate from the abdomen revealed hemolytic staphylococci. The infant was replaced in the incubator. The condtion of the infant immediately after the operation was somewhat improved, probably owing to relief of the distention. Penicillin and streptomycin were given intramuscularly for a period of one week. Gastric suction was maintained for two days. Feeding of water was begun on the fourth postoperative day. Milk was fed to the infant on the fifth postoperative day. For the first five days after the operation, intravenous and subcutaneous fluids and vitamins were given, including 30 cc. of blood on April 27 and 40 cc. of plasma on two occasions. The plasma was given in an attempt to supply some of the protein requirements during this period.

The infant did not vomit at any time postoperatively. She passed flatus on the second postoperative day and had a meconium stool on the fifth postoperative day. A normal stool was noted on the sixth day after surgery. The wound healed well, without evidence of infection. The skin sutures were removed on the 12th postoperative day, while the through-and-through sutures were allowed to remain in place for 15 days.

By the eighth postoperative day the infant was taking her feedings well. She was discharged from the hospital on June 5, 1952, 40 days after the operation. Her weight at this time was 2100 gm. (74 oz.).

Follow-up studies after 18 months reveal a normal-appearing healthy infant. No problem of feeding has arisen; nor has there been any disturbance of bowel movement. The weight at three months had increased to 4080 gm. (9 lb.).

COMMENT

The case presented is one of perforation of the middle small bowel in a premature infant. No obstruction or other cause for the perforation could be demonstrated. The appearance of the bowel suggested a perforated peptic ulcer, but a perforation from other causes could have presented a similar appearance. If the perforation was due to a peptic ulceration, then heterotopic gastric glands must have been present in the wall of the small bowel at the site of the perforation. In spite of the friability of the bowel wall at the site of the perforation, closure was accomplished without undue narrowing of the lumen of the bowel. Biopsy of the area of perforation was not done, because of the added risk it entailed.

With improvements in early diagnosis, antibiotics, and fluid replacement therapy, such recovery should occur more frequently after perforation of a hollow viscus in the newborn infant. Protein administration in the form of serum or plasma is important for proper wound healing. There arose the question of how early to feed such an infant. It was decided to withhold oral feedings for three to five days after the operation.

CONCLUSIONS

A case is presented of a small bowel perforation in a premature infant weighing 1310 gm. (46 oz.). Recovery followed diagnosis and prompt surgical treatment.

Perforation of the small bowel or other hollow viscus should be suspected in an infant with a history of vomiting, abdominal distention, and roentgenographic evidence of pneumoperitoneum. Barium or other contrast media administered by mouth should be avoided.

Vigorous preoperative preparation and early surgical treatment are necessary for reduction in the high mortality rate in this condition.

An underlying bowel obstruction must be relieved at the same time that the perforation is treated.

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CORRECTION

In the article "Ascending Thrombosis of Abdominal Aorta as Fatal Complication of Leriche's Syndrome" in the November issue of the Archives the first two sentences at the top of page 667 should be replaced by the following revised statement:

"Leriche concluded, on the basis of experimental work with dogs, that resection of the bifurcation was possible, and he successfully performed the operation, combined with bilateral lumbar sympathectomy, in 1939. Oudot, in 1950, was the first to replace the resected aortic bifurcation with a homograft, and since then this procedure has been employed a number of times."

Treatment of Postgastrectomy Obstructed Exit Stoma

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Malfunction and obstruction of gastroenterostomy exit stomas is a gravely serious complication of gastric resection. It is somewhat difficult to ascertain how often this trying complication occurs, since it is probably not reported as frequently as the gratifying results. In a discussion of the problem,* Orr and others stated that every surgeon who has done many gastric resections has had some difficulty with malfunctioning gastrojejunal stomas. In cases of apparent exit stoma obstruction reoperation and exploration have been done at various intervals following the initial gastrectomy. Edema of the stomal walls has been found in many of these cases and has been considered an important factor by many surgical clinics. Correction of the fluid, electrolyte, and protein balance has been proved of value in relieving the edema and correcting the obstruction.

Actual mechanical obstruction of the stoma due to excessive cuff formation at the suture line has been encountered. Kinking of the efferent loop has also been found as a cause of obstruction. Another cause of obstruction arises in some cases from pressure of the transverse mesocolon in the posterior gastrojejunostomy. This may be due to pulling up of the stomach segment so that the mesocolon impinges on the jejunal loops. Hemorrhage in the transverse mesocolon can also press on and obstruct the jejunum. Occasionally hemorrhage or infection at the stoma anastomosis forms a firm mass which obstructs the lumen of the stoma. The problem in cases in which there is actual mechanical obstruction is very difficult. While the surgeon waits for the anastomosis to open, there is continuous gastric tube drainage. The patient, therefore, presents a problem in fluid and electrolyte balance. During this period a nutritional deficiency develops, which further complicates the picture. In many instances exploration of the anastomosis reveals no pathological state to account for the lack of gastric emptying. It has been suggested that the condition may be one of gastric atony. Lahey has stated that one must have patience and wait for the stomach to regain tone and start function.[2] Von Prohaska and his coworkers [1] recently have advanced the idea that the poor emptying is due to the position of the exit stoma which allows a small gastric remnant to act as a pouch. This pouch kept filled by gravity impinges on the exit stoma. To prevent that state, he fashions a gastroenterostomy in the most dependent portion of the stomach.

Since most of the cases of poor emptying gastrojejunal stomas are not actual mechanical obstructions and since the teaching has been to wait patiently until the stoma begins to empty the stomach, a dilemma ensues. The surgeon, hoping that the poor emptying is not a rigid obstruction, waits for it to correct itself. At the same time the patient, despite the best parenteral fluid management, gradually becomes a poorer risk if further surgery is needed. If the surgeon does an exploratory operation and finds no obstruction, he has operated in vain on a patient just recovering from a major surgical procedure. If he waits too long before

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* Discussion on Prohaska, Govostis, and Kisteens,[1] pp. 506-507.

exploration, then his patient may not have the stamina left to stand further surgery.

Von Prohaska and his group,[1] as well as Cole, in a discussion of their work have advised enteroenterostomy between the afferent and efferent loops to correct the obstructive phenomena. However, they admit that this operation is not particularly desirable, since the duodenal secretions are thus diverted away from the stomach, where they may have exerted a beneficial neutralizing effect in peptic ulcer disease. The procedure is valuable, nevertheless, as it permits gastric emptying and is not too difficult to do on a poor-risk patient.

I have utilized an anterior gastroenterostomy as a stomach-emptying procedure when the original posterior gastroenterostomy has had exit stomal obstruction. In the presence of an obstruction such as this it is no more difficult to do an anterior gastroenterostomy than an enteroenterostomy. The operation has been successful in providing stomach drainage and does not divert the duodenal secretions away from the stomach remnant. The following cases are representative of those in which such diverting anterior anastomosis was done. In these cases the obstructions were actually mechanical.

Case 1.—Mr. J. B., a 55-year-old man, had experienced (during the last two years) several episodes of severe bleeding from a prepyloric ulcer. On July 11, 1950, he was operated upon, and a gastric resection of the Polya type was performed with the patient under spinal anesthesia. A posterior gastrojejunostomy was done with a short afferent loop. The specimen contained 65% to 70% of the stomach and revealed a prepyloric benign ulcer.

Postoperatively the patient did well until the eighth day. He then developed the annoying symptom of almost constant vomiting. Levin tube suction therapy failed to relieve this vomiting except for temporary periods. On July 24, thirteen days postoperatively, the patient underwent exploratory operation. At this time the omentum was found caught in the healing peritoneal wound and had the appearance of partial strangulation. This omentum was freed and the gastrojejunal site examined. The entrance and exit stoma appeared adequate and both admitted a finger. The Levin tube in the stomach was eased into the upper jejunum for the purpose of feeding and the abdominal wall repair effected.

The patient responded fairly well postoperatively, but after the gastric suction was discontinued, the plaguing symptom of constant vomiting of bile-stained fluid recurred. It was only by the judicious use of intravenous feedings with careful electrolyte balance and transfusions that he was kept alive. Despite all efforts, the course was downhill, since intravenous feeding cannot sustain life permanently. On Aug. 9, almost a full month after the gastric resection, an exploratory operation was done on this very poor-risk patient. Again the actual stoma of the posterior gastroenterostomy seemed adequate, but a firm induration of an inflammatory type was present in the transverse mesocolon, obstructing the exit angle of the stomach. Separation of the existing anastomosis and further resection of the stomach was far too formidable a procedure for this extremely emaciated patient. Therefore, the jejunal loop distal to the posterior gastroenterostomy was used to form a rapidly executed anterior gastrojejunostomy of the usual two-layer type. This made possible the formation of a gastric exit without disturbing the existing posterior anastomosis. After operation the patient made a steady although slow recovery. X-ray studies of stomach function months after operation showed good function. The weight gain was striking. The only disturbing residual has been a diminution of hearing due to streptomycin acoustic neuritis. The patient has been followed for four years, and the stomach function is excellent.

Case 2.—O. H., a 52-year-old white woman, complained of indigestion for about six months. Vomiting had become progressively worse during the last month, and barium meal studies revealed a defect of the stomach in the prepyloric area suggesting carcinoma. On April 27, 1951, surgery was done. An ulcer in the prepyloric area was found, with considerable induration and enlarged firm lymph nodes in the surrounding area. An extensive gastric resection was done, and no liver nodules were observed. The resection was of the Polya type with posterior gastrojejunostomy. Pathological studies proved the lesion to be a carcinomatous ulcer with involvement of the lymph nodes.

After operation the patient did very well. In the next month she gained 10 lb. (4.5 kg.) in weight. This satisfactory state was maintained during the ensuing seven months. At this time postprandial distress developed and then almost constant vomiting. The patient was carrying on an active business and begged to have help so that she could at least liquidate her business advantageously. Although recurrent carcinoma was suspected, no masses were palpable and so the patient underwent surgical exploration. Preoperative x-rays revealed obstruction of the gastric outlet, and the bile-stained copious emesis substantiated this observation. At operation, Dec. 13, 1951, the exit gastrojejunal stoma was found obstructed by carcinoma. There were also small carcinoma nodules in the

Fig. 1 (Case 1, Mr. J. B.).—Postoperational upper gastrointestinal x-ray showing excellent emptying of stomach after anterior gastroenterostomy.

liver at this time. Anterior gastrojejunostomy was effected to prevent starvation. After operation the patient did quite well. She was able to be active until the following April, during which time she was engaged in satisfactory liquidation of her business. She died of the effects of the liver metastases in cholemia, a far less painful end than that of constant vomiting and gradual starvation.

CASE 3.—A. M., a 67-year-old man, had a long ulcer history. In 1949 he had a subtotal gastric resection with a posterior gastroenterostomy. He was admitted to the hospital Nov. 12, 1953, with the history of progressive constipation and vomiting for the last six weeks. During the last month he vomited everything he ate. The vomitus was bile-colored. A barium meal revealed an obstruction of the exit stoma. He was very emaciated and dehydrated on admission. Treatment with gastric suction and intravenous fluids was immediately instituted, and on Nov. 15, an exploratory operation was done.

At surgery a large indurated area was felt at the site of the exit stoma. The stomach was opened, and the mass proved to be a huge stomal ulcer which had burrowed into the mesocolon. Malignant change was suspected, but biopsies failed to show carcinoma cells. The mass involved the blood supply to the transverse colon as well as the jejunum and was so extensive that resection was out of the question in this poor-risk patient. Therefore, an anterior gastroenterostomy was formed. After several days of gastric suction feedings were begun. The postoperative period was complicated by considerable distention in the intestine, but this subsided and the patient was able to gain weight and even travel after two months. The patient's family reported that the patient died about eight months after surgery and that carcinomatosis was found at autopsy.

Since most early postoperative stomas fortunately are not due to actual compression by the transverse mesocolon or masses, I have tried to relieve the condition by a modified weighted tube. A Levin tube made either of rubber or plastic is used. A 1 to 1½ in. (2.5 to 3.6 cm.) distal segment of rubber finger cot is partially filled with 1 to 2 cc. of mercury. This bag is then tied on to the end of the Levin tube securely with silk thread. Several holes are made in the tube proximal to the bag to insure proper suction, and then the tube is passed through the nares and into the stomach. The patient is kept in bed in the most favorable position for migration of the weighted bag to the malfunctioning stoma. Suction of the tube is maintained at the usual level. After 24 to 48 hours it was found that the tube had passed through the stoma, relieving the obstruction. The weighted tube, it appears, acts as a bolus and helps to promote peristaltic waves. It also has weight, which allows gravity to help guide it to the stoma. There is a further gentle hydraulic dilating effect which may actually dilate a tight stoma to allow passage.

Fig. 2 (Case 2, Mrs. O. H.).—Obstruction of posterior gastroenterostomy exit stoma.

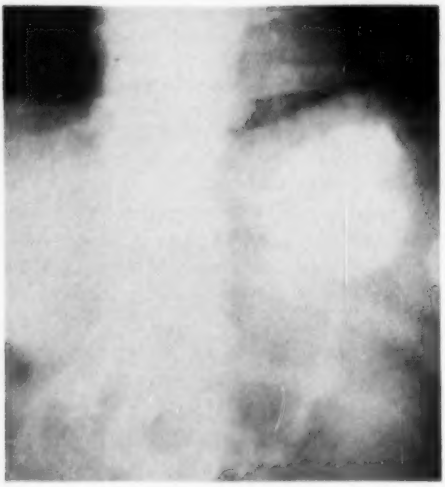

Fig. 3 (Case 4, Mr. J. G.).—X-ray picture showing exit stoma obstruction. There is reflux flow of barium into the afferent loop.

Not only does the tube serve its purpose by opening the stoma, initiating perstalsis, and providing gastric suction during the process, but once it passes the stoma the patient can be fed through the tube directly into the duodenum or jejunum. This allows not only rapid correction of fluid and electrolyte balance but, more important, the administration of concentrated protein and calories. After several days of tube feeding, the tube can be removed and the patient goes on to rapid recovery and is spared further surgical efforts.

The following case reports are examples of different types of gastric outlet stomas as well as different causes of obstruction both treated successfully by this method of intubation.

Case 4.—J. G., a 53-year-old man, had a hemorrhaging duodenal ulcer and some pyloric obstructive symptoms. On Feb. 23, 1954, a 70% subtotal gastric resection was done with a Polya type posterior gastroenterostomy. Three days after surgery the Levin tube was removed. However, vomiting occurred after several hours. Then followed a long and trying period of intubation with vomiting of bile-stained duodenal secretion every time the intubation was stopped. On March 9, seventeen days after surgery, an x-ray with barium revealed obstruction of the efferent gastroenterostomy opening. The afferent stoma was patent. All this time the patient passed very little flatus and had infrequent bowel sounds. Intubation was changed to a mercury bag plastic Levin tube on March 14. The next day it was evident from the return fluid that the tube had progressed into the efferent jejunal loop. The patient began passing gas, and tube feedings were started. On March 16, the tube was removed, and the patient went on to an uneventful recovery. He started to gain weight rapidly and was discharged.

Case 5.—This 69-year-old white man had an old ulcer as well as severe chronic asthma. On Feb. 13, 1954, he was operated upon for a perforated duodenal ulcer which had perforated at least six or seven hours before admission to the hospital. The perforation was repaired with sutures of nonabsorbable (surgical) silk and an omental tag. It was noted at the time of operation that the pylorus was obstructed, but the patient's condition did not warrant more extensive surgery. It was hoped that the edema would subside and allow adequate gastric drainage through the pylorus. Postoperatively the patient's course was somewhat trying because of the severe asthma. However, he recovered fairly rapidly, but there resulted a pyloric obstruction which would not respond to medical management. On March 11, 1954, a Billroth I gastrectomy was done and a huge ulcer measuring 4 cm. in greatest diameter was found just at the pylorus. This had perforated posteriorly at some time previous to the anterior perforation of Feb. 13. Part of the head of the pancreas had to be shaved off with the ulcer to effect removal. The Billroth I anastomosis was completed and a soft rubber drain placed over the pancreatic bed.

Fig. 4 (Case 5).—X-ray picture showing weighted tube which has passed beyond the obstructed stoma of the Billroth I gastrectomy. The distal tube is in the duodenum.

Postoperatively the patient did well. The drainage from the pancreatic bed was only slight to moderate. After three days the gastric suction was discontinued, but a few hours later vomiting of copious gastric accumulations occurred. Careful attention was directed to fluid and electrolyte balance, and gastric suction was continued. Every attempt to discontinue such drainage was met with vomiting after 6 to 12 hours. On March 20, a duodenal fistula was evident, and this readily healed with continuous gastric suction combined with suction of the fistulous tract. On April 11, a full month after gastric resection, the stomach still would not empty. A portion of finger cot about 1½ in. (3.6 cm.) long containing 1.5 cc. of mercury was fixed with silk thread to the end of a plastic Levin tube. This tube was introduced into the stomach, and the patient was kept in a semireclining position to

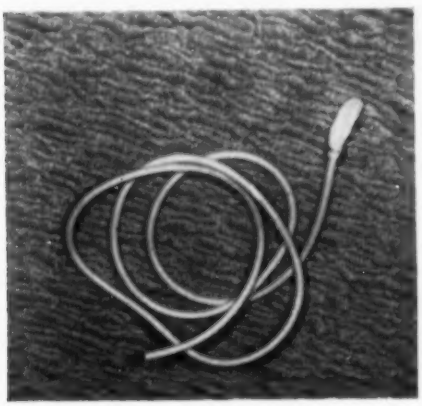

Fig. 5.—Levin tube fitted with small weighted balloon described in reports of Cases 4 and 5.

help gravitation of the weighted bag toward the duodenal anastomosis. The next day the tube had passed into the duodenum. The patient was cachectic from his long period of starvation despite suitable parenteral alimentation. Therefore, tube feedings were started, supplying close to 5000 calories per day. After three days of this the patient improved immeasurably. There had been no vomiting, and so the tube was removed. Oral feedings were resumed carefully, and the patient made a steady recovery.

COMMENT

In cases of actual mechanical obstruction of the exit stoma of gastroenterostomies, the placing of a second gastroenterostomy relieves the obstruction and is an operation tolerated by even a poor-risk patient. This procedure allows emptying of the stomach in cases in which enteroenterostomy does not do so. When actual mechanical obstruction is not present, this procedure empties the stomach without the disadvantages of enteroenterostomy. In cases of obstructed exit stoma due to edema, induration, scar, atony of the stomach, or poor position of the stoma, early use of the modified weighted Levin tube as described by me seems to be of value. The mercury bag acts as a hydrostatic dilator and in Case 5 undoubtedly dilated an indurated scarring anastomosis. In the fourth case, there was probably no induration present. Once the bag has passed through the anastomosis, the tube acts to keep the lumen open. The ability to feed directly into the small intestine after passage of the tube is a great asset. This enables rapid replacement of calories, protein, fluids, and electrolytes in a starving patient.

It is probably better to wait 10 to 14 days before instituting treatment with the weighted bag tube. This waiting period would allow the usual atony or edema to clear up with only suction therapy. Then too, the anastomosis would have time to become firmly healed before the bag dilates it.

SUMMARY

A procedure of producing a second gastroenterostomy in patients with exit stoma obstruction in critical condition is presented.

Poor emptying of exit stoma may be treated without further surgery by the use of a newly proposed weighted bag tube.

A method for dilating the exit stoma and for rapid intestinal feeding is presented.

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The Anesthetist Looks at Pre- and Post-Operative Care

MEYER SAKLAD, M.D., Providence, R. I.

An article in a recent issue of the British magazine *Punch*, entitled "Sleeping Partner," deals with surgeons and anesthetists. It opens with this paragraph: "Surgeons are traditionally accused by the medical profession of introducing two necessary evils—wound infection and anaesthetists. In the past hundred years both of these have fortunately become less dangerous to human life." There are many amusing statements in the article, and the author, in a jovial fashion, tells of the changing relationships between surgeons and anesthetists. He states that formerly "the surgeon took the limelight and ninety per cent of the fee; the anaesthetist at his best was only a Jeeves, ready to smooth the surgical progress of his master, to encourage him in clinical distress, and to temper discreetly his operative enthusiasms," and how after a day's work the anesthetist "left the hospital by bicycle in the dust of the surgical limousine." But, "as operations became longer and anaesthetists had more hours of comparative inactivity to meditate over their humility, they invented a scheme to assert their personalities in the operating theatre. The trick was simple: they repudiated the rag-and-bottle, and invented a machine aglitter with chromium plate and taps to administer the anaesthetic for them." The anesthetists continued to press their advantage, "the machines became bigger and more aggressive, forcing the surgeon to operate uncomfortably in the remaining corner of the theatre." Soon "anaesthetists boldly told their own stories across the towel clips." Now at the end of the day's work two limousines leave the hospital courtyard together. The article closes with this statement. "Anaesthetists are friendly men, and have no malignancy in their new mastery: every one of them thoughtfully thanks the surgeon at the end of the operation for making, with his skill, their superb anaesthetic necessary."

In any event, the partnership definition, sleeping or not, is good, because it means the anesthetist and the surgeon have a common endeavor which for the present purpose is the improved care of the patient, with particular emphasis on pre- and post-operative care. This places an anesthetist discussing this subject under an obligation. It thus becomes my responsibility to discuss this problem from an over-all viewpoint, rather than from the perspective of a single member of the surgical team, the anesthetist. In a study of any problem additional perspectives lend substance to the whole. The more angles of view from which something is considered, the more solid and better balanced becomes the objective.

In being objective one should be critical. Without critical analysis of oneself or of the approach and work of our confreres, progress in the care of the ill would be slow indeed. In a group as closely associated in daily endeavor as the surgeon and the anesthetist, constructive criticism should be encouraged and accepted. This must be based, of course, upon mutual respect of one another's abilities and goals.

With a decreased morbidity and mortality as our goal, let us first look into the causes

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Read before a joint meeting of the Georgia Society of Anesthesiologists and the Georgia Chapter of the American College of Surgeons, Macon, Ga., Nov. 12, 1953.

TABLE 1.—*Cause of Death in 2924 Mortalities After 388,203 Operations*

Number of Operations	Number of Deaths	Mortality
388,203	2924	0.75% (75 per 10,000)

Cause of Death	Number of Deaths	Per Cent
Unknown	72	2.46
Preoperative condition	977	33.44
Premedication	2	.07
Anesthetic agent	4	.13
Anesthetic method	9	.31
Anesthesia management	29	.99
Surgical complication	415	14.19
Medical complication	714	24.41
Combination, pt.'s condition and anesthesia	72	2.46
Combination, pt.'s condition and surgery	541	18.50
Combination, anesthesia and surgery	89	3.04
Totals	2924	100.00

of death following anesthesia or surgery. In 1951, a statistical study was made of postoperative deaths in the New England area by 17 qualified anesthetists, representing 17 institutions, among them university, community, and specialty hospitals. Data were requested on all patients who had died after anesthesia, surgery, or both, for the five-year period from 1946-1950, inclusive. During this period 388,203 patients were operated upon in the hospitals reporting (Table 1). Of these, 2,924 died—a mortality of 0.75%. The cause of death and the number of deaths in each of several categories and their percentages are herewith listed.

It will be noted that 33.44% died as the result of their preoperative condition; 2.46% died as the result of a combination of the patient's condition and anesthesia, and in 18.5% death was the result of a combination of the patient's condition and surgery. Thus, a total of 54.4% of the deaths had a direct or indirect relationship to the patient's condition before coming to surgery. It would seem, then, that if we are to decrease the morbidity and mortality from surgery our most important efforts should be in the direction of improving the patient's condition before he comes to operation.

To study means for the improvement of the patient preoperatively one can well study the statistical material conscientiously and ably collected and summarized by the Department of Anesthesia of the State of Wisconsin General Hospital.[1] It must be noted that any such statistics are of comparative

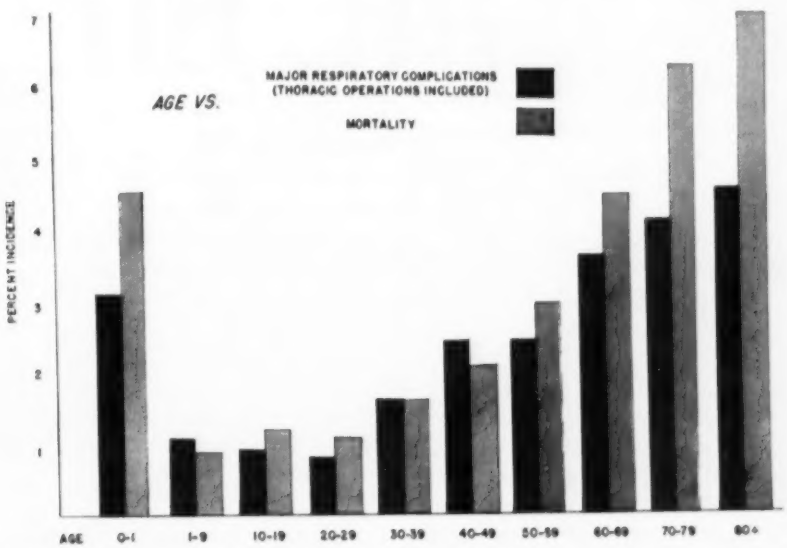

Fig. 1.—Relationship between age and postoperative major respiratory complications and deaths (thoracic operations excluded).

value only to those familiar with the conditions of work in that particular institution. Before any comparative conclusions can be drawn between them and the results obtained in any other institution, the differences in conditions of work must be known and considered.

The following data summarize their findings in regard to the relationship of age, duration of surgery, and physical state, to major respiratory complications, major circulatory complications and deaths, for the years 1941 to 1950, inclusive.

year of life there is an incidence of 3.1% of major respiratory complications and that thereafter it drops abruptly. It is lowest, 0.86%, in the decade of 20 to 29 years of age, and it then gradually rises until the incidence of major respiratory complications is 4.5% in patients over 80 years of age.

The relationship between age and mortality, based on a seven-year total of 36,242 patients, indicates a mortality of 4.5% during the first year of life, which drops to 0.97% and then gradually climbs to a figure of 6.8% in patients over 80 years of age.

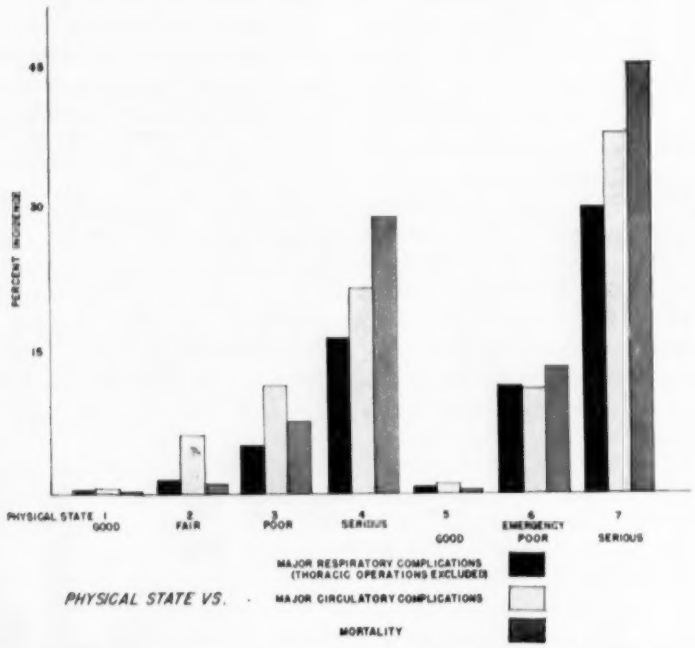

Fig. 2.—Relationship between patient's preoperative physical state and postoperative major respiratory complications, postoperative major circulatory morbidity, and mortality.

AGE

The relationship between age and major respiratory complications and deaths is shown in Figure 1. Incidence by age is charted as 0 to 1 year and then in decades, to 80 and over years of age. In regard to major respiratory complications, the figures were gathered from an eight-year total of 40,620 patients. Patients who had thoracic operations were excluded. Note that in the first

The above presents the relationship between respiratory complications and death to age. They are presented here as examples of the occurrence of untoward events in relationship to a variable over which we have no control.

PHYSICAL STATE

As already stated earlier, the most important variable that affects the end-result is the patient's preoperative condition, i. e., his

physical state. It is important to define the term "physical state." By this is meant an objective measure of the patient's condition. The term is not interchangeable with "operative risk," for by operative risk is meant the correlation between physical state and the hazard of the particular operative procedure to which the patient is to be subjected. Physical state may be classified into seven categories: I to IV—good, fair, poor, and serious for elective surgery, and V to VII—good, fair, and serious for emergency surgery. These categories have been closely defined * and can be recommended for use in your daily work.

The relationship between the patient's preoperative physical state and postoperative complications is shown in Figure 2. Physical state has been designated as mentioned above. Of a total of 46,365 operations, excluding thoracic procedures, note that the incidence of major respiratory complications rises from 0.35% in Physical State I to 16.6% in Physical State IV and, in the emergency groups, from 0.56% to 29.0%. As to major circulatory complications, of a total of 49,972 operations, including thoracic procedures, there was an incidence of from 2.0% in State I to 21.6% in State IV for elective cases, and from 0.94% to 37.7% in emergency operations.

The relationship between the patient's preoperative physical state and mortality in the elective group is 0.02% in Group I to 28.6% in group IV; in the emergency group 0.18% in group V to 45.1% in group VII.

These figures show straight relationships between increasingly poor physical states to postoperative major respiratory and major circulatory complications and death. It is manifest that in order to reduce morbidity and mortality one should try to get the patient who is in physical state IV into III, the one in III into II, and the one who is in physical state II into I. This should be possible in the elective group and, perhaps, even in the emergency group.

The relationship between the patient's preoperative physical state and the trauma of anesthesia and surgery has been emphasized by Moore and Ball,[5] based on the metabolic response of the patient. They speak of the "depletion response," i. e., "a response to trauma in a person already depleted by illness, starvation, previous trauma or operation. The response is also marked by a more 'sensitive' convalescence, meaning that the patient is more readily depleted to the danger point. He is more apt to develop complications such as phlebothrombosis, wound dehiscence, etc."

These are clearly compelling reasons for improving the patient's physical state before operation. While it is true that the patient who is obviously in need of preoperative preparation usually gets some replacement of deficits, the question often arises: Has this repletion been adequate? Because the "marginal" patient usually does well in spite of the fact that he comes to operation not as well as prepared as he might have been, many are apt to adopt the attitude "He'll do all right; we can get away with it." This attitude is to be decried.

Adequate preparation brings up the need for delay in planning operations. There seems much compulsion among many surgeons. There is the drive to go in and get the operation over with. The desire to operate too soon exposes the patient to the hazard of both incomplete evaluation and preparation. This immediacy is sometimes based on economic factors. The patient is often admitted the afternoon or the evening of the day before operation, to save the cost of an extra day or two in the hospital. As a result errors are more frequent. Too often the statement is made "Had we known that the hemoglobin or the blood sugar was abnormal" . . . or whatever it might be . . . "we would perhaps have done something about it." Because of the pressure to save time an active liaison between the internist or the general practitioner and the surgeon is too casual or even lost. Often the patient's personal physician has had no opportunity to record on the chart his knowledge of the patient's previous experience. This is particularly true in emergency procedures.

* References 7 and 8.

The following is a specific example. An infant was admitted with an acute abdominal condition. This diagnosis was reached without consultation with the pediatrician. The patient was operated upon, made an immediately poor recovery, and died. Too late was it learned that the infant had suffered from amyotonia congenita, a condition well known to the pediatrician.

Another factor in this unjustified compulsion on the part of the surgeon, subject perhaps to less criticism, is the tendency for the surgeon's mind to be so focused on the surgical pathologic condition that his concern about the need for separating the patient from the surgical disease takes priority. Too often underlying associated disease processes such as asthma, diabetes, or cardiovascular disease may exist. Photographically speaking, the surgeon must widen his vision, to get a better depth of focus and thus, as far as the patient is concerned, a better perspective, and so recognize associated pathologic states.

INADEQUATE PREPARATION

There perhaps can never be a simple measure of adequate preparation. There is frequently a compromise of the variables, of what is absolutely needed as a minimum and of what would be required for complete preparation. How fully the surgeon prepares his patient depends upon his particular philosophy as to degree of safety. It is manifestly impossible and perhaps not desirable to prepare each patient completely for every possible hazard of surgery. The degree of preparation should perhaps depend upon the type of surgery the patient is to undergo. If the preoperative physical state of the patient could be correlated with the degree of contemplated surgery, one would perhaps obtain a better idea of what degree of safety should be required for the various operative procedures. The response to a given trauma will depend on the patient's ability to withstand or absorb it. Moore and Ball adopted a loose "scale of ten" based on the degree of trauma, a semiquantitative framework in

TABLE 2.—*Scale of Extent of Trauma as Proposed by Moore and Ball*

	1	2	3	4	5	6	7	8	9	10
Ankle sprain										
Simple and minor procedures										
Cholecystectomy										
Appendectomy										
Thyroidectomy										
Hysterectomy										
Colectomy										
Subtotal gastrectomy										
Lobectomy										
Radical mastectomy										
Open reduction of femoral shaft										
Prostatectomy										
Nephrectomy										
Major or compound fractures										
Penetrating wounds of chest and abdomen										
Non-penetrating wounds with visceral injury										
Extensive multivisceral operation for cancer										
Third degree burns of 25% or more of body surface										

Moore, F. D. and Ball, M. R.: The Metabolic Response to Surgery, Chas. C Thomas, Springfield, Ill., 1952

order to interpret the response of the patient to such trauma (Table 2). A patient for a simple minor operation, as for an inguinal hernia, would be exposed to a trauma of scale 2. As the severity of operation increases, so does the scale. Thus, a colectomy rates 5 on the scale, a lobectomy 6, and a multivisceral operation for carcinoma rates 9. There will undoubtedly be some disagreement with such specific placement of the various operations, for they will vary with the experience of different surgeons. The position of the operative procedure on this scale is, therefore, variable. The surgeon himself is an important factor in the degree of trauma. The average surgeon would perhaps fall in the middle of these variables; the better surgeon will inflict the least trauma, whereas the poorer surgeon, because of rough handling of tissues, extended operative procedure, his insistence upon bad operative positions not always consistent with the type of surgery, improper regard for blood loss, will increase the variables to the side of greater trauma. Interpret this if you will as a plea for better surgery. At the same time, poor anesthesia, inadequate attention to hypoxia, carbon dioxide excess, must be counted as increasing the degree of trauma. The anesthetist, therefore, must assume part of the responsibility as to the degree of trauma and do what he can to improve the quality of anesthesia, thus shifting the variable to the side of less trauma. Note from Table 1 that death as a result of management of anesthesia is more than twice that caused by the anesthetic agent and anesthetic method combined.

Certain aspects of pre- and post-operative care deserve more specific mention. Elman,[3] in his book "Surgical Care," has stated "Surgical care should start long before the effect of injury is over." He would agree certainly that definitive care should be started before injury begins. Surgical care could start nowhere better than in the correction of deficits, for a preoperative deficit means an increased morbidity and mortality. Elman states that time out should be taken when possible to measure preoperative deficits and, having measured them, to replace them. Depleted states respond to trauma by the "depletion response" previously referred to.

Common preoperative deficits are hypovolemia and hypoproteinemia. A reduction either in total of circulating protein or in its concentration increases the susceptibility of the patient to hemorrhagic or traumatic shock. There is a direct relationship between hypoproteinemia and increased morbidity and mortality. Ravdin[6] states that "The restoration to normal of a reduced serum protein content must not be taken as an indication that the tissue deficit of protein has been restored, for depleted reserve stores of protein are not, as a rule, significantly replenished until the concentration and total amount of serum protein have returned to normal."

Whipple[9] states "Hemoglobin in its production may draw on the plasma protein but hemoglobin stands apart in the protein economy and does not contribute freely to the protein pool . . . the body guards jealously the fabrication of hemoglobin and given a real need for both plasma protein and hemoglobin the protein flow favors hemoglobin, which under these circumstances is produced in more abundance than the plasma protein." Ravdin states further "Every possible effort, therefore, should be made to correct an existing anemia in protein deficient surgical patients."

Hypovolemia may not be revealed by ordinary laboratory data. The hematocrit and hemoglobin values are notoriously untrustworthy in this regard. Blood volume studies by improved techniques are necessary. Anesthetists are becoming increasingly concerned with the poor tolerance of patients with low blood volume to operation, particularly when pressure breathing techniques are employed, for in such cases venous return to the heart and cardiac output fail early.

Moore and Ball state that "A normal intravascular volume with normal concentrations of proteins, crystalloids and ions are essential preliminaries to surgery and may usually be attained even though cell nutrition remains abnormal. Staging of operations also

has a place here, the first stage often permitting repletion before the second stage."

Certain simple procedures are of great significance, for example, the probably preoperative and unquestionably postoperative placement of a gastric tube. Not only may this prevent aspiration into the lungs, but it prevents also the deleterious effect of a distended stomach on both circulation and respiration.

Antibiotic therapy, when indicated, should be started early. Even in emergency operations, as for peritonitis, there is often delay of several hours for one reason or another. Time out is taken for the treatment of shock or dehydration or to fit the procedure into a tight operative schedule. Advantage should be taken of this interval to obtain a proper blood concentration of the antibiotic. It should be emphasized that patients in peripheral vascular collapse should receive the antibiotic intravenously. Elman [3] stresses the fact that the justification for the use of such early antibiotic therapy "lies in its ability to minimize hepatic damage in portal and biliary infections, to lower the danger of toxic absorption in intestinal strangulation, to prevent wound infection, urinary infection, and particularly pulmonary infection." That such early therapy will reduce the morbidity in perforative appendicitis has been amply demonstrated by Elman.† Fine [4] has recently advanced very good evidence of the role of bacteria in irreversible shock from hemorrhage. If what he has shown holds true also for traumatic shock, this may be another strong indication for preoperative antibiotic therapy.

Surgical care must be continuous, not only on the part of the usual medical personnel, but with whatever additional medical, nursing or ancillary services that may be required. There should be a strong effort for the gathering in of talent, abilities, and services for the improved care of the patient. Breaks in continuous care should be prevented by the development of overlapping services from the preoperative into the postoperative period. With regard to anesthesia, a major advance is the increasing recognition of the need for preoperative evaluation by the anesthetist. The following is an example of the need for such cooperation.

The patient was a middle-aged diabetic with an infected gangrenous leg. Her diabetes was out of control. She was in diabetic acidosis with a carbon dioxide-combining power of 16. She had had a recent coronary occlusion and was in acute congestive failure. Her blood urea nitrogen was 80 mg. and her hemoglobin was 9.7 gm./100 ml. The surgeon was concerned as to the patient's life. The patient was septic, and the surgeon believed that unless the leg were removed the patient would surely die. The internist, too, was concerned. He realized that it would be almost impossible to improve the patient's diabetic status unless the leg was removed. He doubted the patient's ability to tolerate leg amputation because of her cardiovascular state. The surgeon was anxious to proceed immediately, and the internist was torn between treatment of surgical and medical diseases. The anesthetist was to decide. The problem was how to separate the patient from her surgical process and its effect upon her systemically, how to do this without the trauma of anesthesia or surgery, and how to satisfy the medical requirements of the patient. In this instance, the solution was easy. Refrigeration of the extremity with dry ice to well below the freezing point of tissue was suggested and done. This was followed immediately by a drop in the patient's temperature. Her diabetes then became easier to control, and medical treatment improved the congestive failure. Her hemoglobin was elevated by transfusion, and she came to surgery 10 days later. Her leg was amputated, and her immediate convalescence was uneventful. There is no longer any reason why lower extremity surgery should be an emergency, with the possible exception of operations required for the control of hemorrhage.

The more recent trend toward the development of the recovery room on the operating floor, where the patient is under the combined care of the anesthesia and surgical services, has furthered progress in the improved care of the patient.

The recovery room still leaves a weakness in the care of the seriously ill surgical patient. Owing to a busy operative schedule, several seriously ill patients leave the recovery room and are dispersed to different areas of the hospital. The patient has been removed

† Elman, R.: Personal communication to the author.

from an area of specialized care, one of immediate and close supervision, to the care of medical and nursing personnel whose responsibilities are wide and varied. The occasional patient whose needs are greater than the average in his nursing unit may, and does, suffer. The solution seems to be the continued concentration of seriously ill patients beyond the usual recovery room.

The Rhode Island Hospital in planning its new building believes that such concentration is to the best interest of the patient. The area for this purpose termed a "critical ward" or a "specialized service area" has the further advantage that to concentrate skilled services in a given area prevents dissipation of such services. The area planned is of two units, A and B, for the purpose of further subdivision of patients, depending upon their specific needs. The more critically ill, the ones that require the more constant supervision, will go to unit A, and the others to B. Unit A contains 12 beds, 10 of which are in a single large room, and the other two are glass-walled single rooms for patients in extremis. Unit B contains 16 beds. There are two four-bed units so placed that they can be made into a single eight-bed unit. The other eight beds consist of a three-bed and a two-bed unit, and three single rooms. The nursing stations are strategically placed in these units, and a bedroom for a surgical resident is in close proximity. All units in the critical ward are served by an intercommunication system.

This philosophy is economically sound also, for it will relieve the personnel problem through many areas of the hospital. It is important that this area be adjacent to the operating rooms, and in the Rhode Island Hospital it will be placed on the floor immediately above the recovery room. At the end of the operation the determination of direction in which the patient goes becomes a medical decision. Such determination is the result of the surgical and medical opinion of the patient's immediate attendants.

Most patients will go directly from the operating room to their beds. This group will consist of patients who are awake, who have full return of their vital reflexes, and who are in excellent physical state. A large number will go to their rooms by way of the recovery room, there to await the time when it is safe to transport them. The period spent in the recovery room depends upon the time required for these patients to regain their reflexes, to become stabilized, or to await termination of intravenously administered fluid.

On occasion it may be necessary to keep the patient who is in critical condition right in the operating room and then transfer him to the critical ward, either directly or by way of the recovery room. In general, the recovery room is to be used as an area for awaiting return of respiratory reflexes, or a place where ministrations by the anesthetist (for example, tracheal aspiration) are readily available. The critical unit is to serve for the care of the seriously ill. The medical decision is based upon the patient's condition and his need for services, whether or not his reflexes are depressed, and whether or not he is in a safe state to be transported.

It is the philosophy of the medical and administrative personnel of the hospital to use this particular area for other than postoperative patients. To this ward may be brought patients suffering from any condition who require immediate and close supervision. Thus, it is possible for surgical or even medical cases to be brought into an area such as this. The area will be equipped with much of the same material available in the operating room and the recovery room, such as suction apparatus, bronchoscopes, tracheotomy sets, etc.

An example of the so-called "medical" patient who could have probably been benefited by such a room is the following recent experience.

A 6-year-old girl was admitted with some degree of respiratory obstruction. The intern on service was notified. He immediately reached his visiting physician, who happened to be in the hospital and with no delay visited the patient and ordered her to the operating room for tracheotomy. It was soon evident, however, that tracheotomy should be done in the room, and a tracheotomy set was ordered to be sent to the patient's room from the

floor above. By the time it was received and tracheotomy done, the patient was dead. From the time the intern had seen the patient until the tracheotomy was performed was perhaps no more than 30 minutes, but if a critical unit had been available and if the patient had been sent directly to such an area, an endotracheal tube could have been passed or a tracheotomy performed without delay. There is no question that this patient's life might have been saved if the child had been admitted earlier. Since patients such as this one are admitted to institutions, mechanisms should be set up to minimize fatal delay.

To be consistent with the philosophy of continuous medical care, it is proposed that there always be in attendance in this critical ward either a senior surgical or senior anesthesia resident, but on occasion perhaps both will be required. To guarantee the best of nursing, it is perhaps best that the patient's private duty nurse be dispensed with. The occasional "surgical" nurse is soon outmoded in her efficiency. With changing techniques and changing philosophies in the care of patients, the needs of the patient can best be met by one whose daily duty it is to care for such patients.

In short, what should be sought is the surrounding of patients with the same safeguards, personnel, and equipment which protect him in the operating room, for it is in the operating room that mechanisms are set up to handle untoward events better than anywhere else in the institution.

DURATION OF ANESTHESIA AND OPERATION

The relationship between duration of anesthesia and operation, and postoperative major respiratory complications and mortality is shown in Figure 3, the duration being arbi-

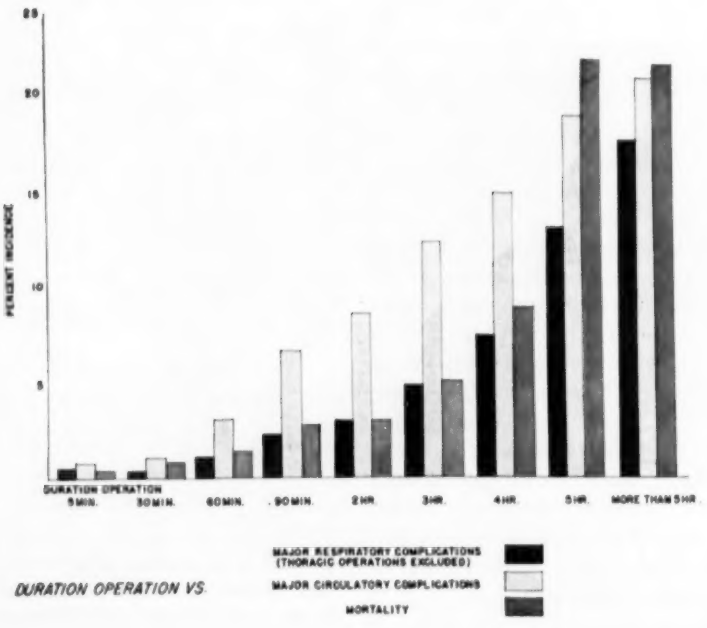

Fig. 3.—Relationship between duration of anesthesia and operation and postoperative major respiratory complications, postoperative major circulatory morbidity, and mortality.

trarily divided into periods of under 5 minutes, 30 minutes, 60 minutes, etc. Note that out of a 10-year total of 46,365 operations, from which thoracic procedures are excluded, the incidence of major respiratory complications following very short operations is relatively low, increasing rapidly with increasing duration of surgery to reach a figure of 17.5% in patients operated on for five hours or more.

In regard to the effect of the duration of anesthesia and operation on the occurrence of major circulatory complications, a study of 49,972 patients operated on over a 10-year period and in which thoracic operations are included, one notes that the incidence of major circulatory complications in these persons extends from a low figure of 0.9% for patients operated on for less than five minutes to a figure of 20.6% in patients operated on for five hours or more.

The third variable in relation to duration of anesthesia and operation was mortality. Of a total of 45,351 patients operated on over a nine-year period, in which thoracic procedures are included, the incidence of mortality varies from 0.5% in patients operated on for less than five minutes to 21.1% in patients operated on for five hours or more.

Because of this unquestioned linear relationship between duration of anesthesia and surgery and major respiratory complications, major circulatory complications, and mortality, an effort should be made to decrease the duration of trauma. Much operating trauma is needless. It is not always necessary, even for teaching purposes, that each of the surgical team manipulate the pancreas, confirm the presence of a stone in the common duct, or palpate a lesion in the esophagus.

It is occasionally necessary, but unfortunately customary, for the surgeon to ask his assistant to close a chest or abdomen after a long and trying operation. Too often the assistant, tired also, delegates it in turn to his junior, who often performs a trying closure in an exhausted patient, with a frustrated anesthetist anxious to begin lightening the anesthesia. True, the junior must learn to close a chest, but the early experience must be carefully chosen, i. e., the chest of a patient who can tolerate an inexperienced, protracted closure.

On the other hand, harm may come from too zealous attempts to cut down operating time. For example, two surgical teams, doing a combined abdominoperineal resection because of time-saving may not offer the full advantage of time saved, for trauma, as well as blood loss in a given interval of time, is doubled. A given loss, of say 1000 cc. of blood, is a greater danger when it is rapid than it is over an extended period. Furthermore, blood loss toward the end of a long operation is less well tolerated than when it occurs early. Time is an important factor in the end-result. When time can be saved it should be done, but not at the expense of increased trauma.

The effects of anesthesia must be added to those that preoperative deficits and surgical trauma have on postoperative convalescence. The patient whose respiration and circulation are overdepressed because of narcotics, drugs, anesthetic agents, or other faulty practices, suffers immensely. With better anesthesia this need not occur. The least that can be done for a patient whose respiration is depressed from any cause is the use of an airway. The nasopharyngeal airway has many advantages for this particular purpose. Nasal oxygen during the transport of the patient to his bed and postoperatively should be more often employed. The nasal catheter must be distinguished in color from the stomach tube to prevent the stomach from being overdistended and, on occasion, ruptured. To prevent this mistake it should be hospital practice that only green tubes be used for nasal oxygen.

Because of the desire on the part of some surgeons, or perhaps even in the rare necessity for a bloodless field, hypotensive agents have been employed as part of the anesthesia procedure. Such hypotensive states lead to postoperative morbidity. Conservatism and caution are urged before these drugs are

used. The true indications for hypotensive anesthesia are small and the contraindications to its use are many.

The acute change in posture at the termination of a surgical procedure may be followed by a marked fall in blood pressure. Many factors may be responsible for the inability of the cardiovascular system to compensate for acute change in posture: blood loss, shock, depth of anesthesia or vasoparesis because of spinal anesthesia or from the use of ganglion-blocking agents. These patients should be handled gently and their position changed slowly.

The immediate treatment of the hypotensive state depends upon its underlying mechanism. Hypovolemia is best treated by blood transfusion. Plasma expanders and vasopressors have limited usefulness. Plasma expanders dilute protein levels and can carry no oxygen. Vasopressors will fail unless the specific cause of hypotension is vasodilation. Blood replacement will be more exact when surgeons have their patient's shed blood measured accurately. Almost uniformly surgeons underestimate the amount of blood lost.

Postoperative hyperpyrexia should be promptly detected and actively treated. Morphine should not be employed for restlessness or excitement unless oxygen want is ruled out. The two-bottle system, one of saline and one of blood, is used commonly for blood administration. Saline should be withheld from many postoperative patients. Dextrose as its substitute seems to be incompatible with blood. We employ a 5% dextrose solution with 0.1% saline for this purpose. This solution seems to be more compatible with blood.[2]

SUMMARY

The surgeon and the anesthetist are constantly endeavoring to improve their end-results. Since an important part of the surgical patient's hospital experience is due to the joint efforts of the surgeon and the anesthetist, their endeavors overlap. This common responsibility places each of these partners in a position to aid the other, especially in pre- and post-operative care. Moreover, such cooperation should engender mutual constructive criticism. The present discussion reviews the areas in which this objective may be achieved.

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Case Reports

OSTEOID OSTEOMA OF MAXILLA

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A review of the literature in regard to the benign tumors of the maxilla and mandible and, particularly, the descriptions of osseous, fibrous, or fibro-osseous neoplasms in that region emphasizes a degree of confusion in terminology which makes accurate classification of any such tumor difficult. Several authors discuss these tumors under a variety of names: osteofibroma, fibrous osteoma, localized osteitis fibrosa, fibromyxoma, fibrous dysplasia, and others.* Phemister and Grimson [6] reported 13 cases of fibro-osseous tumors of the maxilla and mandible, each containing variable amounts of trabecular bone with fibrous marrow; some of these tumors showed giant cells, myxomatous changes, or hemopoietic elements. The authors remarked on the probable parallelism between such "fibrous osteomas" in membranous bone and the benign osteomas and chondromas of cartilaginous bone.

Despite this nosologic confusion, which tends to make one chary of describing an "unusual" tumor of this region, it would appear that osteoid osteoma in the skull is exceedingly rare. We have been able to find but one reported case of osteoid osteoma in this region, that of a 36-year-old woman with such a tumor in the anterior mandible.[7] This report did not include histologic verification.

Jaffe originally described five cases of this unusual tumor of bone in 1935.[8] His diagnostic criteria are succinct: "a) osteoid with partial peripheral calcification b) thin, newly formed, centrally placed trabeculae c) loose, vascular, fiber marrow d) presence of numerous osteoblasts and osteoclasts midst the trabeculae." The tumor has a characteristic roentgenologic and gross appearance. Since Jaffe's original report, literally hundreds of articles have described this tumor in nearly every bone in the body. Except for Pritchard and McKay's case [7] of presumptive osteoid osteoma in the mandible, nearly all have occurred in long bones and vertebrae. Excellent review articles have been written by Dockerty and co-workers [9] and Sherman.[10]

The appearance of a classic osteoid osteoma in the maxilla, as recorded below, is of interest in that it may be suggestive evidence that this strange tumor has its temporal origin sometime before the transformation of the primitive mesenchyme into true osteoblastic tissue. The mesenchymal cell destined to form the membranous bone of the maxilla is supposedly morphologically different from that destined to be the precartilage cellular component in endochondral ossification.[11] However, the ultimate differentiation of the bone-forming cell is identical in both membranous and endochondral ossification, and it is probable that the origin of an osteoid osteoma may be in a more adult cell.

REPORT OF A CASE

R. B., J. H. H. 536856, a 17-year-old Negro youth, was admitted to the plastic surgery service because of a painful swelling of the right upper jaw of four and one-half months' duration. He recalled having been struck in that region by the fist of a playful child sometime near the onset of his illness. Shortly thereafter, he noted progressive slow enlargement of the cheek, with increasing tenderness and pain. This was marked with mastication. He saw his dentist, who referred the patient to this hospital.

From the Division of Plastic Surgery, Department of Surgery, The Johns Hopkins Hospital.

*References 1 through 5.

Figs. 1 and 2.—Roentgenologic detail of the osteoid osteoma (postoperative specimen), showing the spherical lesion within the alveolus, with a central nidus and radiating dense marginal spicules of trabecular bone.

The only significant abnormalities found on physical examination were limited to the region of the right maxilla. The right side of the face was edematous. In the region of the upper alveolus,

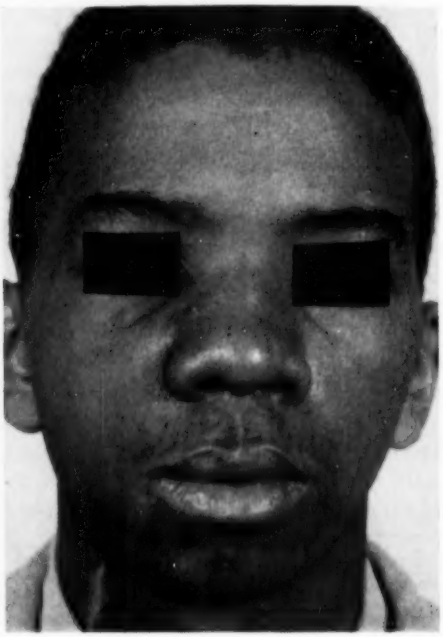
Fig. 3.—Operative photograph showing modified Fergusson type incision for exposure of maxilla and the extent of resection of the tumor.

Fig. 4.—Photomicrograph of the tumor illustrating the central nidus, partially calcified osteoid, and radiating trabecular bone. Numerous osteoblasts and osteoclasts fill the spaces between the bony spicules.

from the lateral incisor to the first bicuspid, was a rounded, firm mass which bulged into the mucobuccal sulcus and extended into the hard palate on the right for a distance of about 1.5 cm. There was no mucosal ulceration. The mass was minimally tender and fixed and felt bony. It measured about 2.5 cm. in diameter.

The hemogram was within normal limits. Roentgenologic examination showed a dense round lesion, with radiating, fibrillary structure and a radiolucent center. The mass elevated the floor of the right antrum and extended into the hard palate. The lower antrum was clouded (Figs. 1 and 2).

Fig. 5.—The patient three weeks postoperatively. Dental prosthesis not yet in place, but deformity is minimal.



Biopsy of the lesion was carried out on Dec. 11, 1953, and the histologic diagnosis was "osteoid osteoma." Accordingly, the patient was returned the following week to the operating room and a limited right maxillectomy performed. The maxilla was exposed through a modified Fergusson incision, and the alveolar process was split just to the right of the medial incisor. A narrow margin of hard palate was incised, and the ostotome directed beyond the alveolar tuberosity and across the lower anterior wall of the antrum, which had been elevated by the growth. The nasal process was then cut across, without the nasal cavity being entered, and the antral mucosa was stripped free (Fig. 3). Skin grafting of the buccal defect was not thought necessary, owing to its small size. The patient's postoperative course was unremarkable. The antral pack was removed in 10 days, at which time the cavity was epithelializing cleanly. A dental prosthesis was fitted eight weeks later (Dr. J. E. Pyott) and has proved entirely satisfactory.

Pathologic examination of the excised specimen showed a roughly spherical mass of irregularly calcified osteoid tissue, at the periphery of which the osteoblasts seemed to line up radially. The central portion of the tumor contained a few small spicules of cancellous bone, around which numerous osteoclasts were seen. The spaces in between were filled with a fibrous tissue containing blood vessels. The tumor seemed to have arisen from the superior plate of the alveolar ridge and adjacent hard palate. It blended inferiorly into the cementum surrounding the tooth root. Soft tissues were displaced but not invaded (Dr. Stanley Eversole) (Fig. 4).

Follow-up to date (May 1954) has shown no evidence of recurrence, and the patient remains asymptomatic (Fig. 5).

SUMMARY

The appearance and excision of a classic osteoid osteoma in an unusual location, the maxilla, is described.

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Scientific Exhibits

PRIMARY TUMORS OF THE SOFT TISSUES OF THE EXTREMITIES EXCLUSIVE OF EPITHELIAL TUMORS

An Analysis of Five Hundred Consecutive Cases

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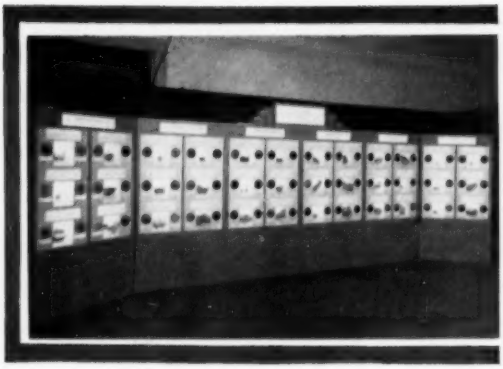


Exhibit as set up at San Francisco.

This exhibit presents some of the benign and malignant soft-tissue tumors of the extremities, exclusive of epithelial structures and lymph nodes.

The tumors are grouped into six categories, one cabinet being devoted to each category. Each cabinet contains six of the more unusual and more important tumors which are considered to be derived from a single basic cell type. The incidence of the six categories, and of the individual tumors within each category, was derived from analyzing 500 consecutive cases of primary soft-tissue tumors of the extremities seen in the surgical pathology laboratory in the interim of approximately 2½ years. In this series, 14.6% of all the tumors, including the nonneoplastic masses, were malignant.

I. FIBROMATOUS TUMORS (See Pages 463-464)

In our series 12% of the primary soft-tissue tumors were in this group. Sixty-seven per cent of the fibromatous tumors were malignant. The fibroblast is the mesenchymal element from which these neoplasms are derived.

II. LIPOMATOUS TUMORS (See Pages 465-466)

In our series 33% of the primary soft-tissue tumors were in this group. Three per cent of the lipomatous tumors were malignant. The lipoblast is the mesenchymal element from which these neoplasms are derived.

III. ANGIOMATOUS TUMORS (See Pages 467-468)

In our series 13% of the primary soft-tissue tumors were in this group. Five per cent of the angiomatous tumors were malignant. The vasoformative mesenchymal cell is the element from which these neoplasms are derived.

IV. NEUROMATOUS TUMORS (See Pages 469-470)

In our series 19% of the primary soft-tissue tumors were in this group. Four per cent of the neuromatous tumors were malignant. The neurilemma cell is the neuroectodermal element from which these neoplasms are derived.

V. MYOMATOUS TUMORS (See Pages 471-472)

In our series 3% of the primary soft-tissue tumors were in this group. Thirty-eight per cent of the myomatous tumors were malignant. The myoblast is the mesenchymal element from which these neoplasms are derived.

VI. MISCELLANEOUS TUMORS (See Pages 473-474)

In our series 20% of the primary soft-tissue tumors were in this group. Forty-six per cent of the miscellaneous tumors were synovial in origin, 48% were fibrous xanthomas, and 6% were unclassified. Sixteen per cent of the miscellaneous group were malignant.

Presented at the meetings of the American Academy of Orthopaedic Surgeons, Chicago; the American Medical Association, San Francisco, and the American College of Surgeons, Atlantic City, N. J., 1954.

From Mayo Clinic and Mayo Foundation, Section of Surgical Pathology (Dr. Soule), Section of Orthopaedic Surgery (Dr. Ghormley, with the collaboration of Drs. John C. Ivins, Paul R. Lipscomb, Edward D. Henderson, H. Herman Young, William H. Bickel, Mark B. Coventry, Joseph M. Janes and Einer W. Johnson Jr.) and Museum of Hygiene and Medicine (Dr. Bulbulian, Director).

I. FIBROMATOUS TUMORS

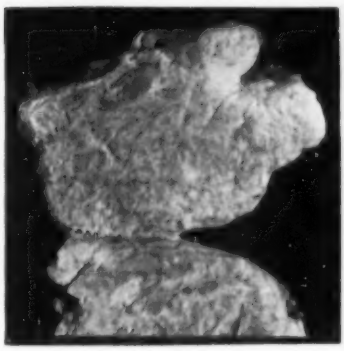
FIBROMA

8% of Fibromatous Tumors

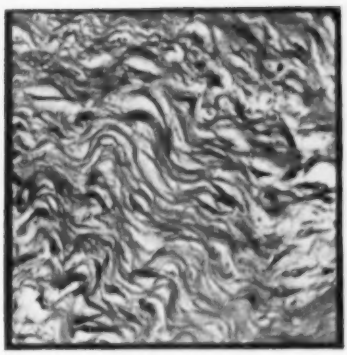
Fibroma is a benign neoplasm of the soft tissues. It originates from fibroblasts, which form a firm, dense, nontender, encapsulated mass. It is usually attached to the deep fascia or intermuscular septa.

Cut Surface.—Interlacing bundles of white to pink-white, glistening tissue are arranged in a somewhat lobulated manner.

Microscopic.—Wide bands of dense, wavy collagen with rather widely dispersed well-differentiated fibroblasts with elongated mature nuclei. Mitotic figures are not found. Small, well-formed blood vessels are occasionally seen. Sections from many parts of the tumor present a uniform picture.



The somewhat lobulated, encapsulated appearance with a cut surface of dense interlacing fibrous bundles is characteristic.



The long, spindle cells are mature fibroblasts scattered among dense, collagen bundles (H. & E.; × 400).

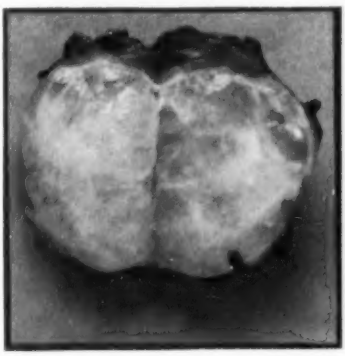
FIBROMYXOMA

15% of Fibromatous Tumors

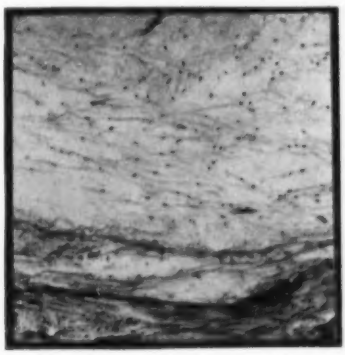
Fibromyxoma, including its variant, the myxoma, is a benign mesenchymal tumor originating from fibroblasts. It arises from fascia and intermuscular septa to form an encapsulated, gray-white, nontender, moderately firm to rubbery mass.

Cut Surface.—Well-defined capsule of fibrous tissue with varying amounts of a glistening mucoid matrix interspersed with fibrous septa. Occasionally cyst formation and hemorrhagic degeneration may be seen.

Microscopic.—Myxomatous areas are composed of a matrix of connective-tissue mucin containing stellate cells connected by a delicate network of reticulin. The malignant counterpart of this tumor, fibromyxosarcoma, can be misdiagnosed as fibromyxoma.



Well-formed septa and a well-delineated fibrous capsule. The translucent myxomatous portions are clearly discernible from the pure fibrous element.



Fibrous capsule and relatively acellular, mucoid matrix of the myxomatous component (H. & E.; × 60).

EXTRA-ABDOMINAL DESMOID

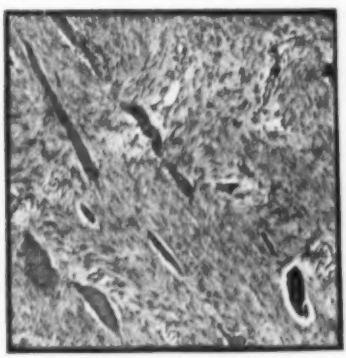
10% of Fibromatous Tumors

This tumor is a benign, but paradoxically invasive, often recurring tumor of the extremities. Its growth potential varies widely, and recurrence may be rapid. Typical site is the belly of a muscle. The long axis of growth is parallel to muscle fibers. Compression of surrounding structures may produce a pseudocapsule.

Cut Surface.—Glistening white-pink, firm, interlacing bundles of fibrous tissue. Large tumors may undergo cystic or myxomatous degeneration. Penetrating the tumor for a distance of 2 to 4 mm. are inclusions of striated muscle.

Microscopic.—Hallmark of the desmoid is the giant cell which evolves from degenerating striated muscle. Mitotic figures may be seen occasionally.

The lack of true capsule and the glistening white interlacing fibrous bands are typical. Long axis of growth is parallel to muscle fibers.



Degenerating, striated muscle cells displaying evolution of the typical giant cells (H. & E.; × 60).

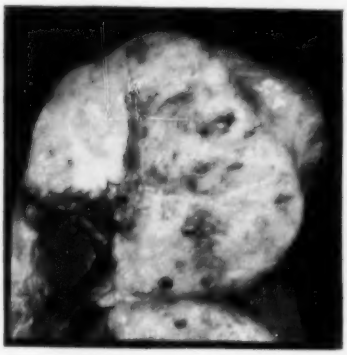
FIBROSARCOMA

This Group and Its Variants Constitute 67% of Fibromatous Tumors

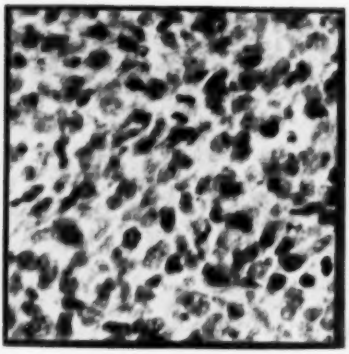
Fibrosarcoma is the commonest malignant neoplasm primary in the soft tissues; it has a wide range of malignancy and growth potential. It metastasizes via the blood stream.

Gross.—These tumors vary from the small, white, firm growths of low grades of malignancy to large degenerating soft growths of higher grades of malignancy. They often appear encapsulated.

Microscopic.—The degree of malignancy varies little within the same tumor. Cells may vary from well-differentiated, spindle cells forming abundant collagen, to highly anaplastic, round cells devoid of the fine reticulin network usually associated with primitive formation of collagen. Mitotic figures increase with the degree of malignancy.



Poor encapsulation, soft consistency and hemorrhagic degeneration indicate a high degree of malignancy.



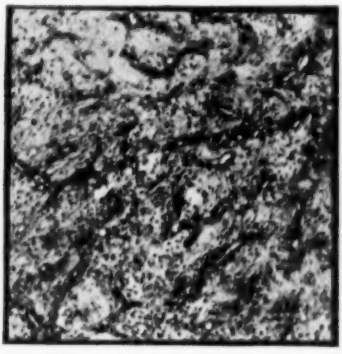
Highly undifferentiated, anaplastic cells displaying pathologic mitotic figures and no collagen formation (H. & E.; × 400).

FIBROMYXOSARCOMA

A Variant of Fibrosarcoma

Fibromyxosarcoma and myxosarcoma are grouped together. Since myxomatous areas are frequently found in liposarcomas, rhabdomyosarcomas and malignant mesenchymomas, care must be taken to exclude these tumors. Myxomatous areas do not indicate degeneration but, rather, imply deposition of connective-tissue mucin by a primitive mesenchymal cell, the fibroblast. These areas are best described by alluding to Wharton's jelly of the umbilical cord. This category of tumors, therefore, implies the finding of fibromatous and myxomatous tissue. The tumor may be highly malignant, but well-differentiated tumors will recur after inadequate excision. Eight of 11 patients in our series had multiple recurrences.

Extensive, recurrent, multilobulated, myxomatous mass with extensive involvement of plantar muscles, ankle and veins. This is unusual location for a malignant tumor.

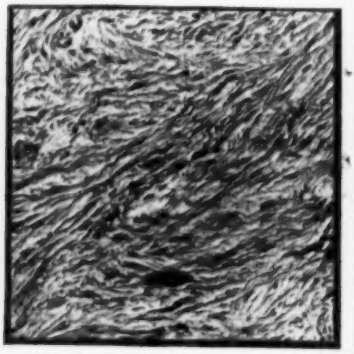


Relatively acellular but pleomorphic tumor exhibiting numerous blood vessels and a mucoid matrix (H. & E.; × 60).

FIBROSARCOMA IMITATING FIBROMAS AND DESMOIDS

This variant of fibrosarcoma is difficult to diagnose because its morphologic features and clinical behavior are difficult to correlate. The dermatofibrosarcoma protuberans, which frequently displays mitotic figures, rarely metastasizes; the apparently encapsulated, seemingly well-differentiated fibromas which have few mitotic figures often recur and may metastasize. This unexpected activity by these innocuous-appearing fibrous tumors has led some to classify all well-differentiated fibrous tumors as nonmetastasizing fibrosarcoma. A malignant neoplasm on rare occasions will closely resemble a desmoid histologically.

This third recurrence represented by multiple nodules over foot and calf. It involved the posterior tibial and popliteal veins.



Well-differentiated fibroblasts and dense collagen bundles. Single giant cell resembles inclusion of degenerating, striated muscle (H. & E.; × 150).

II. LIPOMATOUS TUMORS

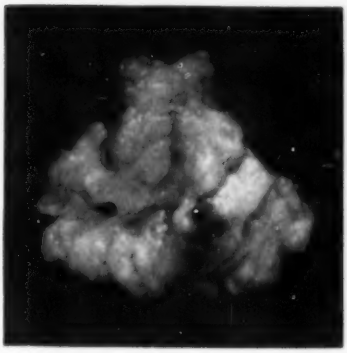
INJECTION GRANULOMA

1% of Lipomatous Tumors

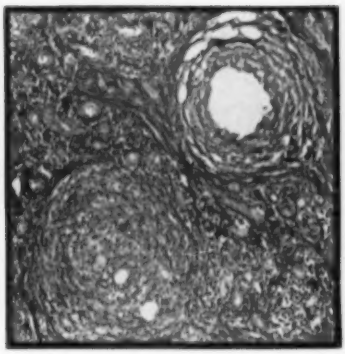
Lipoid granuloma is a reactive process in adipose tissue to endogenous or exogenous lipids. Initiating factors include injected material, trauma, inflammatory processes or spontaneous ischemia. Injected lipids produce an enlarging, often painful mass with or without calcification.

Cut Surface.—Fibrofatty mass of tissue with pools of lipids. Chalky masses of calcium salts may be seen.

Microscopic.—Adipose tissue partially replaced by dense fibrous tissue surrounding empty spaces, granulomatous tissue and foreign-body giant cells. Stains for fat demonstrate lipid in empty spaces.



Slowly enlarging mass of fibrofatty tissue. Lobules containing lipid were seen throughout the mass.



Granulomatous reaction surrounded by fibrosis and lymphocytic infiltrates. Vacuoles represent lipid-filled spaces (H. & E.; × 60).

HIBERNOMA

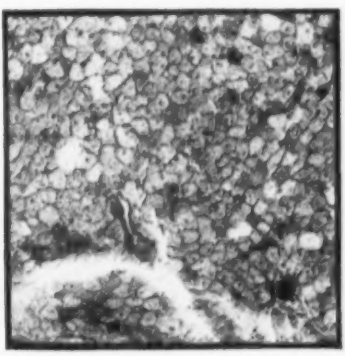
No Cases in Our Series of 500 Tumors

Hibernoma is a rare benign primary neoplasm which resembles the hibernating gland of animals. It originates from lipoblasts of the primitive vascular mesenchyme. It appears in regions where "brown or embryonal fat" is found, namely in the interscapular region, axilla, neck, and retroperitoneal space.

Gross.—Firm circumscribed golden-tan mass with a concentrically laminated pattern. Large vascular spaces are more prominent about the periphery.

Microscopic.—Fibrous capsule and multiple septa form compartments containing polygonal cells with small central nuclei and multiple, fat-filled vacuoles. Transitions to adult fat cells are seen.

Circumscribed yellow-tan mass with prominent vascular channels. Lobulated, concentric laminations are well demonstrated.



Polygonal cells in typical pavement arrangement. Small nuclei in cytoplasm containing multiple fat-filled vacuoles (H. & E.; × 60).

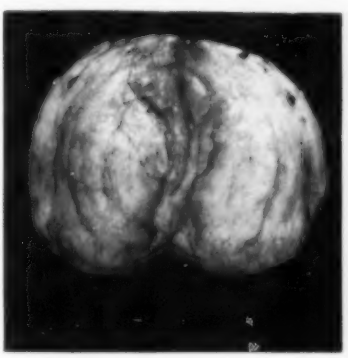
LIPOMA

96% of Lipomatous Tumors

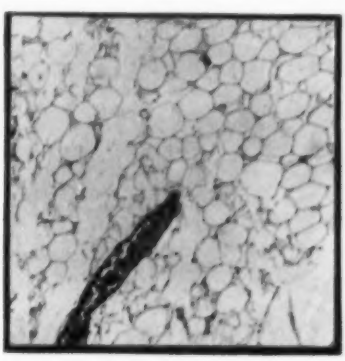
Lipoma is the commonest benign neoplasm primary in soft tissue. It is a slow-growing tumor of the lipoblast, a cell which originates from the vascular mesenchyme. It usually is in subcutaneous tissue, rarely in intermuscular spaces or in the muscle (myolipoma). It has a distinctive radiolucency. Degeneration is followed by calcification or bone formation. Recurrent lipoma (1%) represents multiple foci of origin.

Cut Surface.—Encapsulated, lobulated, orange to lemon-colored, greasy mass. Color and consistency vary with fibrous-tissue content.

Microscopic.—Large cells with univacuolated cytoplasm and eccentric flattened nuclei. Septa result in lobulated pattern.



Thin fibrous capsule, lobulated and greasy cut surface. Deep yellow color denotes a sparse fibrous element.



Delicate membrane, univacuolated cytoplasm and flattened nuclei of adult fat cell produce honeycombed appearance (H. & E.; × 60).

LIPOSARCOMA

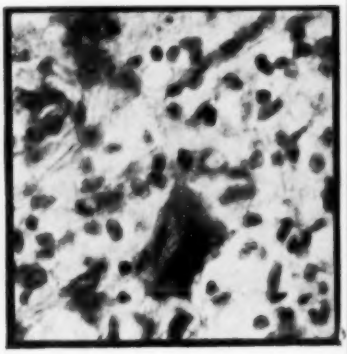
This Group and Its Variants Constitute 3% of the Lipomatous Tumors

Liposarcoma is an unusual malignant tumor of the lipoblast primary in soft tissue. It usually arises deep in the intermuscular spaces of the thigh and buttock. Growth potential varies widely. It is firmer than the lipoma and may be somewhat radiolucent. The encapsulated, lobulated mass frequently has satellite nodules. It is disseminated by the blood.

Cut Surface. — Pseudoencapsulation with variations from soft, gelatinous, hemorrhagic zones to yellow-tan or white, more firm areas.

Microscopic.—Findings vary from small spindle and "signet" lipoblasts containing droplets of fat with few mitotic figures, to bizarre tumor giant cells with voluminous cytoplasm.

Semiencapsulated firm, lobulated tan mass with hemorrhagic degeneration. Cyst was filled with old blood. Unusual subcutaneous location.



Tumor, giant cell, with foamy cytoplasm interspersed with spindle and embryonal lipoblasts (H. & E.; × 400).

LIPOMYXOSARCOMA

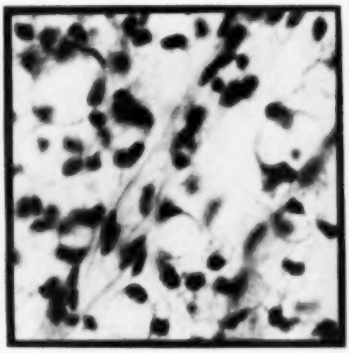
A Variant of Liposarcoma

Lipomyxosarcoma is a malignant variant of the liposarcoma which has similar location and growth potentials. Myxomatous elements may obscure the true character. Degeneration may be extensive. The histologic appearance varies from well-differentiated cells to bizarre anaplastic types. The liposarcoma may be confused with fibromyxosarcoma.

Cut Surface.—Tumors of low degree of malignancy appear encapsulated with gelatinous soft translucent areas. Yellow tinge varies with lipoid content. More highly malignant tumors contain more areas of degeneration and less of the myxomatous component.

Microscopic. — Stellate cells in matrix of mucin associated with malignant lipoblasts, which vary from signet cell type to giant cell forms with foamy cytoplasm.

Recurrent tumor in surgical scar. Gross features differ little from those of fibromyxosarcoma. Signet form of lipoblasts serves to classify neoplasm.



Uniform signet cells and proliferating blood vessel evenly dispersed in myxomatous matrix (H. & E.; × 400).

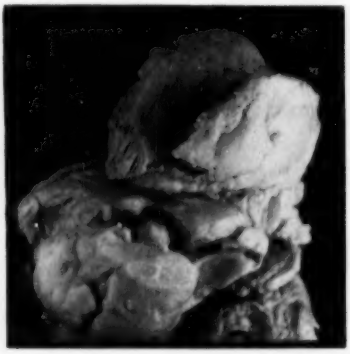
LIPOSARCOMA

Associated With Lipoma

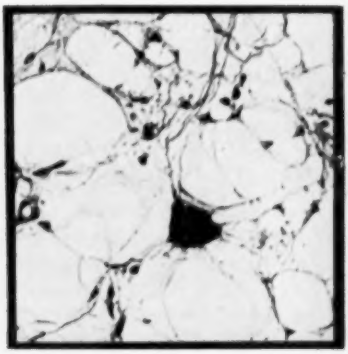
Liposarcoma may arise in a lipoma. However, since adult fat cells are often associated with malignant lipoblasts, interpretation is difficult. Location, incidence, and rate of growth militate against such a possibility. Recurrent lipomas with foci of liposarcoma suggest that the malignant component was originally overlooked. Suspicion should be directed toward recurrent, deep-seated lipomas near the trunk or those displaying changes in color and consistency.

Cut Surface.—This may have the typical yellow color and soft consistency of lipoma together with whitish firm portions.

Microscopic.—Adult fat cells may be seen with occasional anaplastic foamy lipoblasts.



Massive recurrence at site of previously excised deep-seated lipoma which weighed 2750 gm. Encapsulation, color and consistency compatible with recurrent lipoma.



Anaplastic lipoblast with foamy fat-filled cytoplasm associated with adult fat cells (H. & E.; × 200).

III. ANGIOMATOUS TUMORS

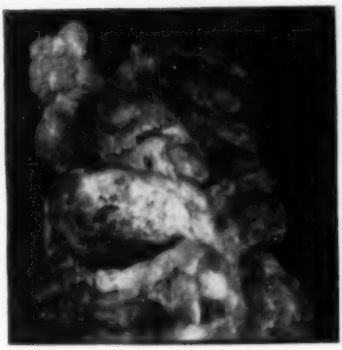
HEMANGIOMA

76% of Angiomatous Tumors

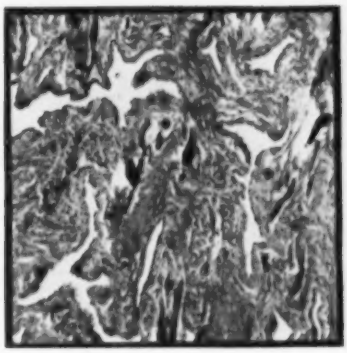
Hemangioma is a benign growth originating from vasoformative mesenchyme and is composed of blood-filled endothelial-lined spaces. True nature (that is, simple proliferating, true neoplasia, simple ectasia of pre-existing spaces or hamartoma formation) is controversial. Neoplasm may be discrete or diffuse; the latter frequently involves muscle, nerves, and occasionally bone. More than 50% of the tumors of both types cause enlargement and pain.

Cut Surface.—Poorly circumscribed soft, blood-filled, spongy mass often containing visible spaces. Thrombosis and phleboliths found in a third of the cavernous type.

Microscopic.—Small (capillary) and large (cavernous) endothelial-lined blood-filled spaces may be seen in fibrous stroma.



Soft, blood-filled mass involving the sartorius muscle. Macroscopic spaces and foci of thrombosis readily demonstrated.



Cavernous, endothelial-lined spaces in dense fibrous stroma containing remnants of striated muscle (H. & E.; × 60).

LYMPHANGIOMA

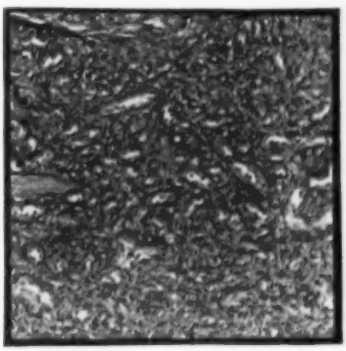
5% of Angiomatous Tumors

Lymphangioma is an unusual benign tumor originating from vasoformative mesenchyme and composed of lymph-filled endothelial-lined spaces. Lymphangiomas may be of capillary cavernous, or cystic (cystic hygroma) type. At times they are congenital, and frequently involve skin and mucous membrane. Cystic hygromas are native to the neck and axilla. Sprouts of endothelium result in invasive tendency. Stroma often contains nests of lymphocytes.

Cut Surface.—Encapsulated or poorly defined cystic or solid, pale-red mass. Lymph often mixed with blood exudes from surface.

Microscopic.—Capillary and cavernous spaces are lined with endothelium. No erythrocytes are seen in most clefts. Fibrous stroma is variable and may contain nests of lymphocytes.

Progressively enlarging, encapsulated, solid mass. Lymph escaped on sectioning.



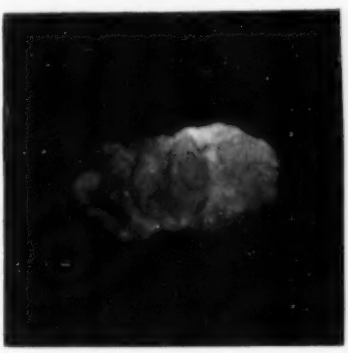
Closely packed lymph vascular spaces lined by plump endothelial cells. Little fibrous stroma (H. & E.; × 100).

GLOMUS TUMOR

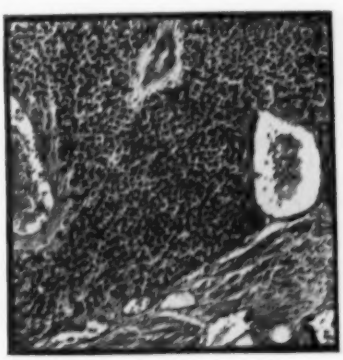
13% of Angiomatous Tumors

Glomus tumor is a benign tumor originating from the pericytes of Zimmermann which comprise the outer coats of capillaries and glomera. A variable number of fine nerve filaments often are important components. The tumor rarely exceeds 1 cm. in diameter. It appears as a purplish-red encapsulated mass in nail beds (one third of the cases), joints, and subcutaneous tissue of extremities. Characteristic lancinating pain follows slight pressure.

Microscopic.—Vascular spaces of varying size are filled with blood and have typical round epithelioid cells in their walls. Over-all organoid pattern. Nerve fibers frequently are seen.



Very painful, encapsulated, purplish-red, solid tumor in subcutaneous tissues.



Large vascular spaces. Round uniform pericytes external to vascular lumina (H. & E.; × 100).

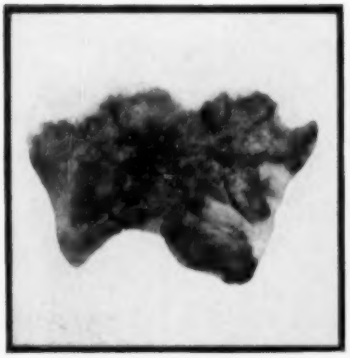
HEMANGIO-ENDOTHELIOMA (INFANTILE)

5% of Angiomatous Tumors

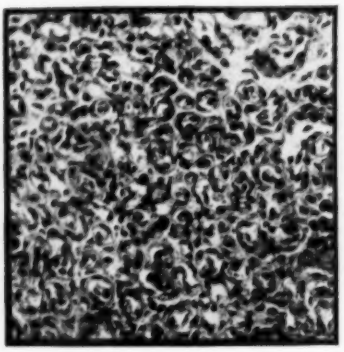
Hemangioendothelioma is a controversial and poorly understood entity. By our definition it is a tumor of low-grade malignancy, which rarely metastasizes and which arises from the endothelium of blood vessels. It is usually seen in skin of young children. It may exhibit rapid invasive growth to involve muscle. It appears as a deep red, frequently ulcerated, infected indurated and diffuse lesion of the skin.

Cut Surface.—Pink, solid tissue replacing subcutaneous fat and infiltrating muscle.

Microscopic.—Plexiform pattern of small vascular channels. Endothelial proliferation within basement membrane of capillaries produces nests and cords of cells. Anaplasia is slight; only occasional mitotic figures are seen.



Skin and subcutaneous tissue are indurated, thickened and red. Central region of ulceration and infection.



Vascular space lined by proliferating, anaplastic endothelial cells (H. & E.; × 200).

HEMANGIOPERICYTOMA (BENIGN)

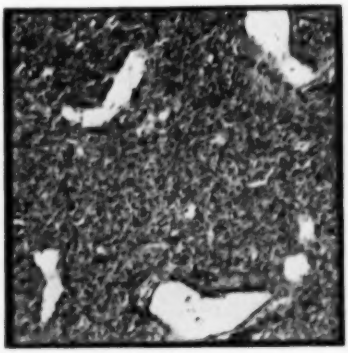
1% of Angiomatous Tumors

Hemangiopericytoma is a rare benign neoplasm arising from pericytes of capillaries and possibly glomera. The malignant counterpart is difficult to differentiate histologically. Epithelial and spindle cells suggest a generic relationship to glomus tumor and vascular myoma. Some hemangiopericytomas exhibit aggressive growth (20% are malignant).

Cut Surface. — Circumscribed, nodular, superficial or deep, small or large, firm deep-red or tan mass. Calcification and necrosis are rare.

Microscopic.—Obvious and occult vascular channels. Concentric layering of plump spindle and round cells outside vascular lamina. Poor organoid pattern. Connective-tissue stroma variable.

Large pseudoencapsulated vascular mass with areas of necrosis. Lack of pain and large size help exclude vascular myoma and glomus tumor.



Plump, spindle and epithelioid cells adjacent to large and occult vascular spaces (H. & E.; × 85).

KAPOSI'S SARCOMA

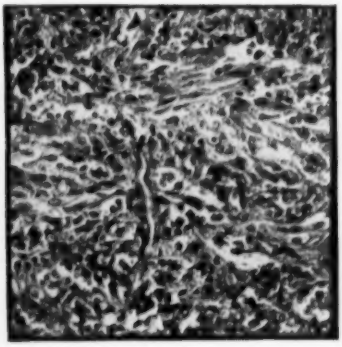
No Cases in Our Series of 500 Tumors

Kaposi's sarcoma is a malignant vascular neoplasm usually in the cutis of the extremities of Jewish and Italian men past 40 years of age. It probably arises from angioblasts and is closely allied to angiosarcoma and lymphangiosarcoma. Age, race, sex, erratic growth of multicentric origin, predilection for cutis and symmetrical involvement of extremities serve to establish the lesion as a separate entity.

Gross.—Blue-red macules, progressing to indurated blue-black plaques with satellite red nodules. Centripetal spread and visceral involvement usually occurs late.

Microscopic.—Metamorphosis of "inflammatory" and "granulomatous" stages results in the sarcoma picture of malignant spindle cells, vascular spaces and old blood pigment.

Typical blue-red satellite macules surrounding indurated blue-black plaques and nodules. Primary lesion which was a red macule between third and fourth toes has undergone complete resolution.



Interlacing cords of plump anaplastic spindle cells surrounding blood-filled vascular spaces (H. & E.; × 150).

IV. NEUROMATOUS TUMORS

AMPUTATION NEUROMA

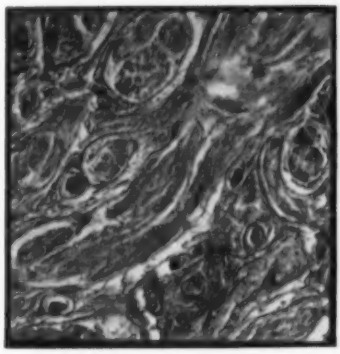
42% of Neuromatous Tumors

Amputation or traumatic neuroma is a non-neoplastic tumor of peripheral nerves. It consists of neurilemma cells, fibroblasts, and neurites. The proliferating neurilemma cells form a tangled mass of potential neurilemma sheaths and regenerating axons. Fibrous tissue arises from the connective-tissue coverings of the nerve. Neuromas fixed to dense scar tissue may be painful.

Cut Surface.—Bulbous end of peripheral nerve is a white firm mass frequently attached to dense scar tissue.

Microscopic.—Tangled mass of nerve sheaths and neurites are admixed with dense fibrous tissue.

Bulbous, firm, white, painful enlargements of nerves. Regenerated nerve sheaths have grown into amputation scar.



Tangled, regenerated nerve sheaths composed of neurilemma cells admixed with fibrous tissue (H. & E.; × 60).

SCLEROSING NEUROMA (MORTON'S TOE)

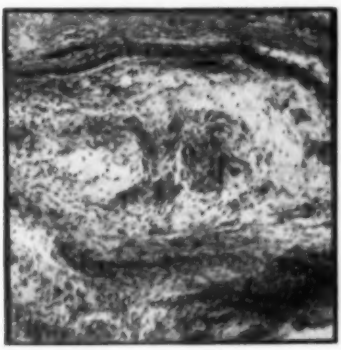
24% of Neuromatous Tumors

Sclerosing neuroma is a non-neoplastic, painful tumor usually involving the fourth digital nerve of the feet. It has been postulated that the nerve is traumatized because of (1) its superficial location and (2) its origin from the yoke formed by the lateral and medial plantar nerves on the plantar surface of flexor digitorum brevis muscle causes tension on the nerve by flexion of the toes.

Cross Section.—Small fusiform enlargement of nerve and component roots. Encapsulated firm pearly white. Rarely cystic. Edema and sclerosis result in tumor.

Microscopic.—Early edema and demyelinization are followed by proliferation of neurilemma cells and fibrosis.

Fusiform neuroma at bifurcation of digital branches. Typical fusiform, encapsulated, white mass.



Edema associated with demyelinization of nerve fibers. Beginning proliferation of neurilemma cells (H. & E.; × 60).

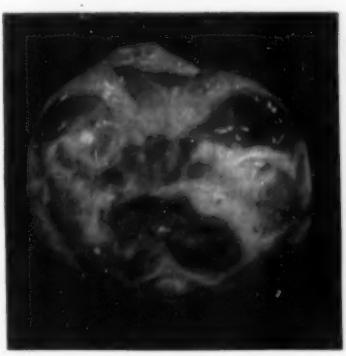
NEURILEMMOMA

21% of Neuromatous Tumors

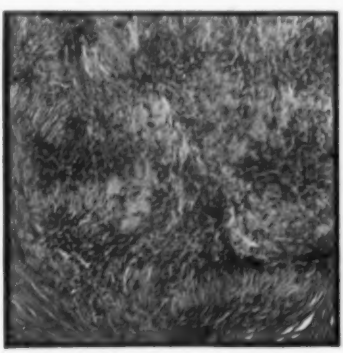
Neurilemmoma is a benign neoplasm of peripheral nerves which originates from neurilemma cells of Schwann's sheath. Tumors are encapsulated and vary in size. Fibrils of small nerves are incorporated in capsule; in larger nerves an eccentric nodule is found. Pressure results in dysfunction of the nerve. Multiple tumors are rare.

Cut Surface.—Encapsulated solid white mass. Cystic degeneration with hemorrhage and fatty change are seen in large tumors.

Microscopic.—Spindle cells arranged in bands form delicate reticulin fibers. Nuclei are in parallel rows with intervening clear areas (Verocay body). There are haphazardly arranged neurilemma cells, cystic spaces, and fibrous thickening of blood vessels.



Encapsulated mass with fascicles of nerve incorporated in capsule. Cystic, hemorrhagic and fatty degeneration.



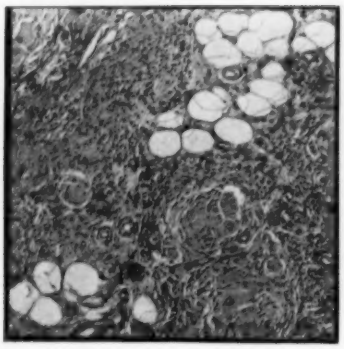
Bands of spindle cells with palisading of nuclei to form Verocay bodies (H. & E.; × 60).

NEUROFIBROMATOSIS (VON RECKLINGHAUSEN'S DISEASE)

9% of Neuromatous Tumors

Neurofibroma is a benign tumor composed of peripheral nerve elements (neurites, neurilemma cells, and fibrous investments of nerve). Multiple tumors, strong hereditary background and associated skin lesions are characteristic. Age of onset and growth potential are unpredictable. Isolated encapsulated nodules or diffuse tortuous thickening is seen in nerves. In skin diffuse proliferation of small terminal nerves causes redundant, soft folds. Elephantiac hypertrophy of soft parts and occasionally overgrowth of bone, café-au-lait spots, pigmented nevi, and fibroma molluscum complete skin picture. Centripetal spread of plexiform type of tumor in peripheral nerve to cord or malignant change with metastasis results in death.

Soft, diffuse mass involving subcutaneous tissue. Apparent overgrowth of fat and connective tissue with no demarcation between tumor and normal tissue.



Proliferation of neurilemma cells invading fat and forming structures suggestive of nerve end-organs (H. & E.; × 60).

NEUROFIBROSARCOMA ARISING IN NEUROFIBROMATOSIS

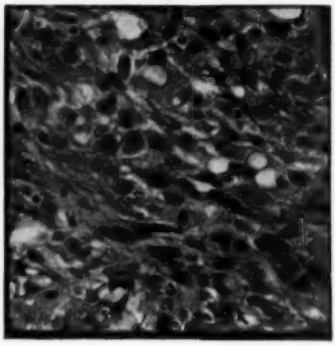
2% of Neuromatous Tumors

Neurofibrosarcoma arising in neurofibromatosis accounts for 50% of the malignant nerve tumors. Metastasizing spindle cell tumors eventually develop in 5 to 10% of patients with multiple neurofibromatosis. Evidence points to origin from neurilemma cells. The onset of malignancy is unpredictable. The malignant neoplasm may arise in a neurofibroma or independently. Insidious onset with early dissemination via the blood stream (rarely the lymph) is the rule.

Cut Surface.—Firm, usually deeply seated, pseudoencapsulated, white, fibrous mass with varying degrees of degeneration.

Microscopic.—Long slender spindle cells, scanty reticulin, and mitotic figures.

Large, encapsulated, firm, malignant mass and many smaller benign nerve tumors. Café-au-lait spot and pigmented nevi.



Highly undifferentiated plump spindle cells. Pathologic mitotic figures (H. & E.; × 200).

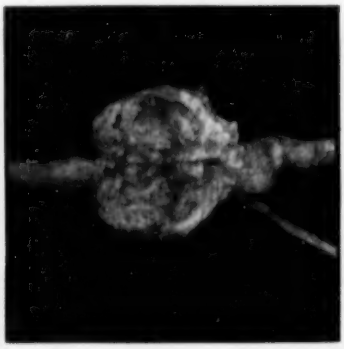
PRIMARY NEUROFIBROSARCOMA

2% of Neuromatous Tumors

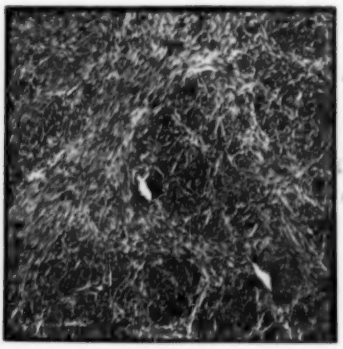
Neurofibrosarcoma is a malignant, primary neoplasm of large peripheral nerves apart from von Recklinghausen's disease. Origin from neurilemma cells versus perineural fibroblasts is debatable. Since microscopically it cannot be differentiated from fibrosarcoma, only those tumors growing in large peripheral nerves are considered in our series. Insidious onset and blood-borne metastasis are the rule.

Cut Surface.—Fusiform, slightly lobulated, firm, white, encapsulated mass expanding nerve. Usual spread is up and down the nerve trunk and its branches.

Microscopic.—Bands of long anaplastic spindle cells are often at right angles to each other. There is a fine reticulin network. Palisading is inconstant and mitoses are variable.



Fusiform, firm tumor involving the superficial and deep peroneal nerves. Extends in sciatic nerve 7 cm. above gross tumor.



Cross section of sciatic nerve. Fascicles of nerves separated by direct extension of malignant cells (H. & E.; × 60).

V. MYOMATOUS TUMORS

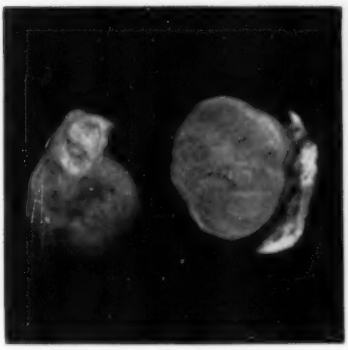
LEIOMYOMA

8% of Myomatous Tumors

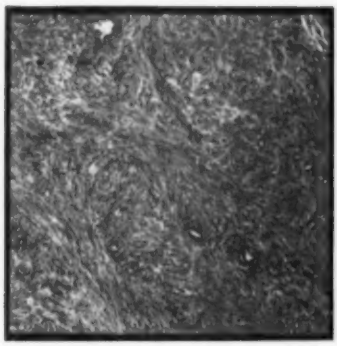
Leiomyoma is a rare, benign neoplasm usually of the subcutaneous tissues. Arrectores pilorum muscles or blood vessels are theoretically the site of origin. Vascular origin suggests relation to vascular myoma and glomus tumor. Leiomyomas are clinically nontender and may be multiple.

Gross.—Encapsulated, white, firm mass with a whorled appearance on cut surface. It rarely exceeds 2 cm. in diameter and has little tendency to degenerate.

Microscopic.—Relatively avascular neoplasm features long spindle cells whose nuclei show blunt rounded ends, and myofibril in cytoplasm. Lack of mitosis is hallmark of benignancy.



Characteristic subcutaneous location of nontender, encapsulated, firm, white mass, 1.3 cm. in diameter.



Interlacing bands of spindle cells. Slightly plump nuclei and absence of collagen are typical (H. & E.; × 60).

GRANULAR CELL MYOBLASTOMA

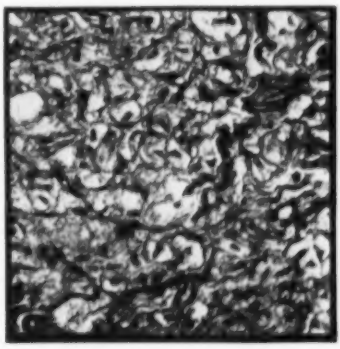
No Cases in Our Series of 500 Tumors

Granular cell myoblastoma is a benign neoplasm; it is usually in skin or subcutaneous tissues when in the extremities. Origin (neural versus myoblast) and biology (degeneration versus neoplasia) are controversial. In our opinion, it is a neoplasm originating from myoblasts. This asymptomatic, slowly growing, firm mass rarely exceeds 2.5 cm. in diameter. Epithelial hyperplasia is peculiar to skin lesion.

Gross.—Circumscribed firm white to pink mass may be associated with nerve.

Microscopic.—Fascicles of large, round cells with granular cytoplasm and small, central nuclei. Transitions from elongated multinucleated pink-staining cells with cross striations may be seen.

Asymptomatic, movable nodule of several years' duration in subcutaneous tissues.



Large cells with small uniform nuclei and granular cytoplasm invading connective-tissue stroma (Trichrome; × 200).

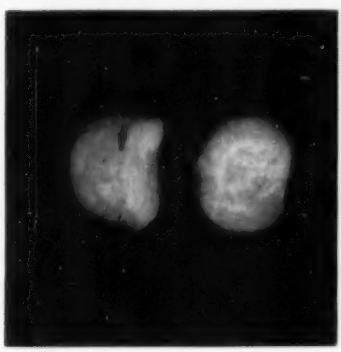
VASCULAR MYOMA

54% of Myomatous Tumors

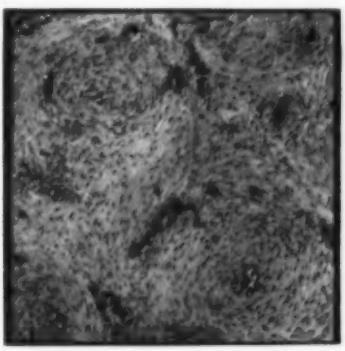
Vascular myoma is a benign, primary neoplasm found in the subcutaneous tissues of the extremities. It is thought to arise from "pericytes" of capillaries with apparent transformation into smooth muscle. Occasionally tumor arises from media of a vein. Severe paroxysm of pain is attributed to spasm of smooth muscle. No nerve fibers.

Gross.—Encapsulated, brownish-gray, firm mass rarely exceeding 1 cm. in diameter. Cut surface has whorled appearance, reminiscent of a uterine fibroid.

Microscopic.—Smooth muscle cells arranged in whorls about small vascular spaces devoid of elastic laminae. Transitions from round to spindle cells noted.



Very painful encapsulated, brownish-gray, firm mass in subcutaneous tissues.



Small vascular spaces with concentric layers of round cells with transitions to spindle cells (H. & E.; × 60).

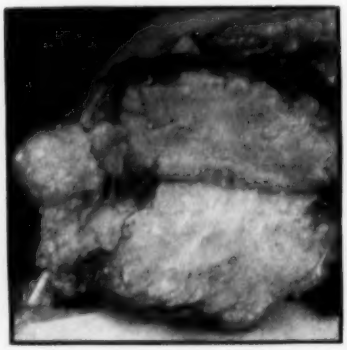
LEIOMYOSARCOMA

8% of Myomatous Tumors

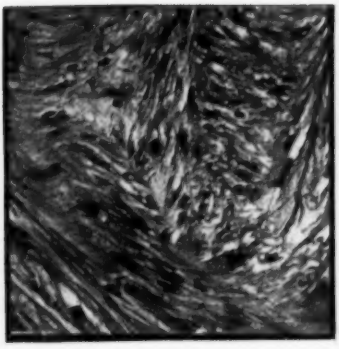
Leiomyosarcoma is a rare, malignant tumor in the extremities. Contrary to its benign counterpart, it arises deep in the soft tissue (walls of blood vessels?). Local recurrences following excision, and blood-borne metastasis are frequent.

Gross. — Circumscribed, firm, white, nodular mass. Cut surface reveals firm, whitish-brown, interlacing bundles and nodules. Tendency to degeneration is slight in soft tissues of the extremities but great in retroperitoneal spaces.

Microscopic. — Bundles of elongated spindle cells with blunt-ended nuclei. Intracellular myofibrils in cytoplasm. Bizarre cells less important than number of mitotic figures in determining malignancy.



Large circumscribed nodular, whitish-brown, firm mass situated deep in muscle.



Mitotic figures considered most important single criterion for malignancy. Myofibril in cytoplasm (H. & E.; × 200).

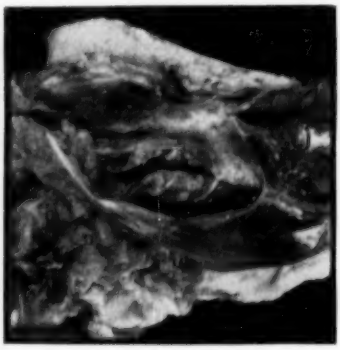
MALIGNANT MYOBLASTOMA

15% of Myomatous Tumors

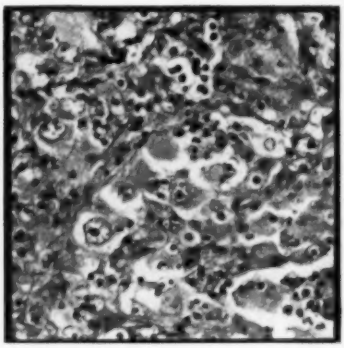
Malignant myoblastoma is a rare, malignant neoplasm so named because its constituent cells resemble malignant rhabdomyoblasts. Its controversial origin is the same as granular cell myoblastoma. It is associated with striated muscle. It recurs and occasionally metastasizes if it is incompletely excised. Cross striations when present (rarely) tend to confuse tumor with the more malignant rhabdomyosarcoma.

Gross. — Poorly encapsulated, white, elastic nodule rarely exceeding 3 cm. in diameter, usually in skeletal muscle.

Microscopic.—Organoid or more pleomorphic pattern of large round eosinophilic granular cells admixed with bizarre more anaplastic forms. Mitotic figures are often numerous.



Poorly encapsulated, elastic, white mass in striated muscle.



Large, round, pleomorphic cells with pink-staining granular cytoplasm. Resemble cells of granular cell myoblastoma (H. & E.; × 200).

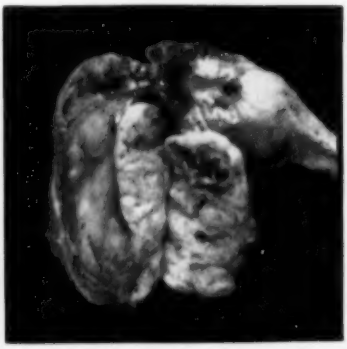
RHABDOMYOSARCOMA

15% of Myomatous Tumors

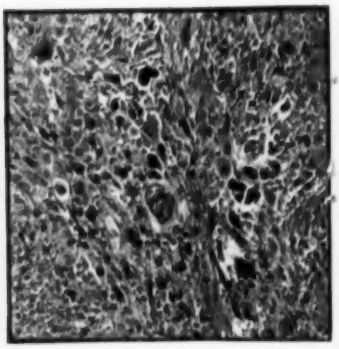
Rhabdomyosarcoma is an uncommon, malignant neoplasm associated with striated muscle. It arises from the rhabdomyoblast. Growth is usually rapid and aggressive. It metastasizes via the blood stream (occasionally via lymphatics). Cystic degeneration with hemorrhage is seen in large tumors.

Gross.—Large, poorly encapsulated, degenerating mass associated with striated muscle.

Microscopic. — Cellular morphology varies within same tumor. Small round cells, strap-like cells with tandem nuclei and tumor giant cells complete picture. Myofibrils and cross striations are variable.



Large, circumscribed, partially cystic, degenerating tumor which has eroded wing of scapula. Pain was noted months before mass became apparent.



Admixture of round, strap and tumor giant cells. Bizarre nuclei, granular cytoplasm with suggestive cross striations (H. & E.; × 100).

VI. MISCELLANEOUS TUMORS

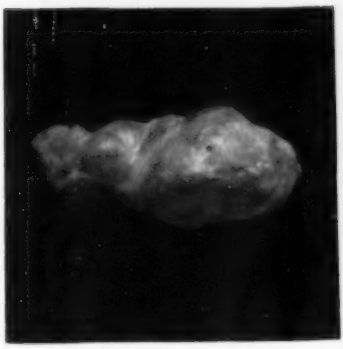
GANGLION CYST

1% of Miscellaneous Tumors
(2% of Synovial Tumors)

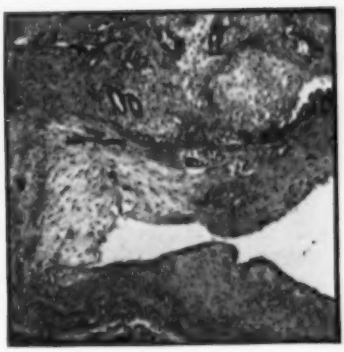
Ganglion cyst is a benign tumor associated with tendon sheaths and joints. Herniation of synovial membrane, displacement of synovial tissue, and degenerative change in synovium constitute theories of formation. Favorite locations are wrist, dorsum of foot, and knee. Pedicle frequently is attached to synovium of joint.

Gross.—Multilocular, tense, cystic mass filled with clear mucinous fluid.

Microscopic.—Findings vary from simple cystic spaces in dense fibrous tissue to cavities lined by synovial cells. Foci of mucinous degeneration are associated with microcysts in fibrous tissue. Proliferating synovial cells may be seen in the cyst wall.



Multilocular bluish-white tense mass. Long pedicle extended into synovium of wrist.



Synovial-lined cystic space. Fibrous wall with focal area of mucinous degeneration (H. & E.; × 60).

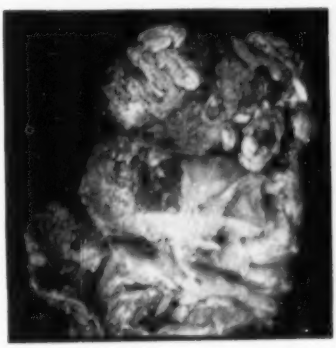
GIANT CELL TUMOR OF TENDON SHEATH

35% of Miscellaneous Tumors
(76% Synovial Tumors)

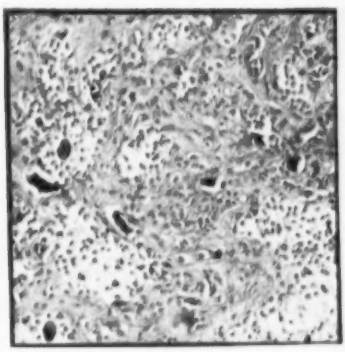
Giant cell tumor of tendon sheath is a benign neoplasm associated with the tendon sheaths and joint capsules in hand, foot and knee. This slowly growing, firm mass often causes erosion of bone. Recurrence follows incomplete removal.

Gross.—Firm, encapsulated, gray mass with yellow and brown streaks.

Microscopic.—Sheets and cords of oval and spindle cells of synovial origin with variable fibrous stroma. Clefts are lined by plump cells. Number of giant cells and lipid-filled phagocytes is variable. Foci of hemosiderin may be seen. Highly cellular areas showing multiple cells in mitosis may be confused with synovial cell sarcoma.



Unusually large, reddish-gray, firm mass with xanthomatous areas. Brownish streaks of old blood.



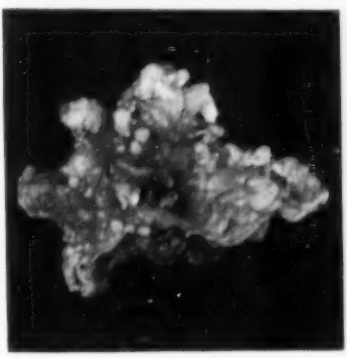
Characteristic giant cell in sea of oval and spindle cells. Focal deposition of hemosiderin (H. & E.; × 100).

OSTEOCHONDROMATOSIS OF BURSA

No Cases in Our Series of 500 Tumors

Chondromatosis is a benign, cartilaginous metaplasia of synovium, often associated with degenerative joint disease. Rarely bursae may exhibit this phenomenon. Appearance is that of a sac containing multiple, white, round, cartilaginous bodies, either sessile or attached by narrow stalks to synovial lining of wall. Loose bodies may be free in the associated fluid. Osteochondromatosis denotes secondary ossification. Onset of lesion rarely is associated with trauma.

Microscopic.—Heterotopic masses of benign cartilage intimately associated with synovium.



Bursal sac with heterotopic masses of cartilage in wall of capsule.

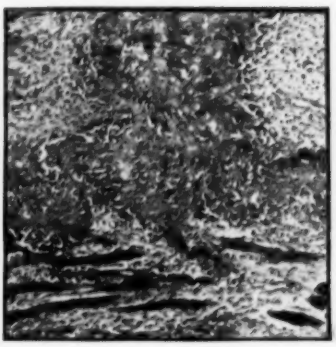
Plaque of metaplastic cartilage in fibrous wall of bursa (H. & E.; × 60).

MYOSITIS OSSIFICANS

No Cases in Our Series of 500 Tumors

Myositis ossificans is a limited, tumefactive process of repair usually resulting from trauma. Progressive form of childhood is idiopathic. Injury apparently initiates metaplasia of primitive pluripotential fibroblast to osteoblast. The rapid deposition of osteoid, bone, and fibrous tissue replaces and separates striated muscle bundles. Regular pattern of osteoid and lack of anaplasia rule out malignancy. Some are of the opinion that osteogenic sarcoma may develop in myositis ossificans.

Poorly circumscribed mass of firm, grayish-red, slightly gritty tissue, which developed 12 days following injury.



Edge of lesion featuring separation of striated muscle by islands of young osteoid and fibrous tissue (H. & E.; × 60).

SYNOVIAL CELL SARCOMA

10% of Miscellaneous Tumors

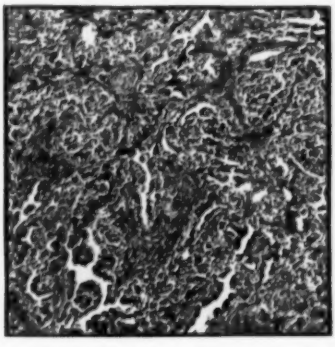
(22% Synovial Tumor)

Synovial cell sarcoma is a malignant neoplasm arising from synovia of joints, bursae, or tendons or from totipotential mesenchymal cells of soft tissue. It is an aggressive growth and prone to recur and produce blood-borne (80%) and lymphatic (10%) metastasis. Commonest sarcoma of hands and feet. Predatory for region of knee and thigh. Speed of growth variable and calcification frequent.

Gross. — Circumscribed, homogeneous, gray, firm mass often degenerating.

Microscopic.—Cuboidal and spindle cells in varying ratio. Former often line slits and gland-like spaces. Pleomorphism and mitosis moderate. Inadequate sampling may lead to erroneous diagnosis of fibrosarcoma or metastatic adenocarcinoma.

Large, rapidly recurrent, cystic, painful mass. Primary nodule noted 10 years prior to first excision.



Clefts lined by tall columnar cells. Such areas suggest metastatic adenocarcinoma (H. & E.; × 60).

MALIGNANT MESENCHYMOMA

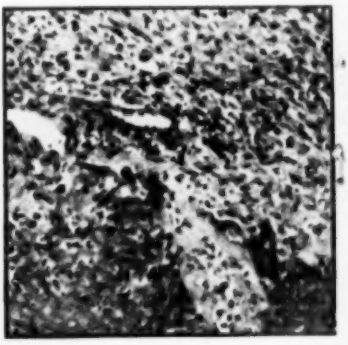
No Cases in Our Series of 500 Tumors

Malignant mesenchymoma is a primary neoplasm of soft tissue. The name, as proposed by Stout, implies origin from a totipotential primitive mesenchymal cell which in its neoplastic evolution often produces the picture of a "malignant mixed tumor" of soft parts.

Gross. — Circumscribed solid or partially cystic mass varying from white to yellow-orange in color. Cut surface may be gritty.

Microscopic.—Composite cells in varying proportion may include malignant fibroblasts, lipoblasts, rhabdomyoblasts, osteoblasts and chondroblasts.

Large circumscribed, cystic, degenerating mass. Yellow-orange areas firm and gritty. No bone involvement.



Focus of malignant osteoblasts with fine atypical osteoid pattern. Typical osteogenic sarcoma (H. & E.; × 100).

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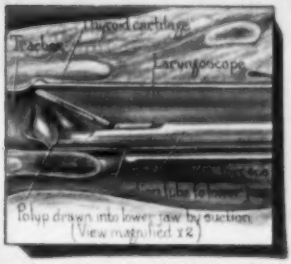


Illustration shows a polyp drawn by suction into lower jaw of Broyles laryngeal suction forceps.

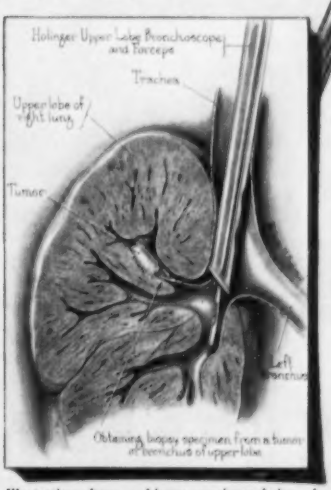
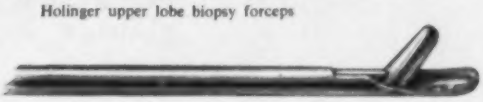

Holinger Upper Lobe Bronchoscope and Forceps
Trachea
Upper lobe of right lung
Tumor
Left bronchus
Obtaining biopsy specimen from a tumor at bronchus of upper lobe

Illustration shows a biopsy specimen being obtained from a tumor with the Holinger upper lobe biopsy forceps.

WRITE FOR LITERATURE DESCRIPTIVE OF THE MANY OTHER TYPE FORCEPS.

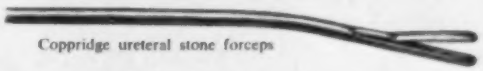
Broyles laryngeal suction forceps

Holinger upper lobe biopsy forceps



Lowsley grasping forceps

Turell rotating rectal biopsy forceps



Coppridge ureteral stone forceps

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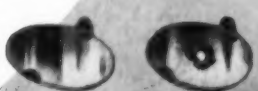

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